

MAY
1952

Chemical Engineering

IN TWO PARTS:

PART I

PART II

PROCESS INSTRUMENTATION

... New Tools

... Trends

... Economics

64-PAGE REPORT BEGINS ON P. 161

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ONE DOLLAR

This Guide is an effort to compress into one place the maximum amount of information on process instrumentation for use in preliminary selection. It is not intended as a substitute for the literature, nor for manufacturers' catalogs and commentaries with their representatives. Its main emphasis is

the first 22 sections, or on the principal process variables and the primary sensitive elements for measuring them. The remaining sections deal with electrical variables, measuring devices, transmitters and telemeters, automatic controllers and final control elements.

CREDITS — Information from which this guide was developed was secured from many sources, including both literature and industry. The following members of the instrument industry generously supplied data especially for this purpose.

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CHEMICAL ENGINEERING

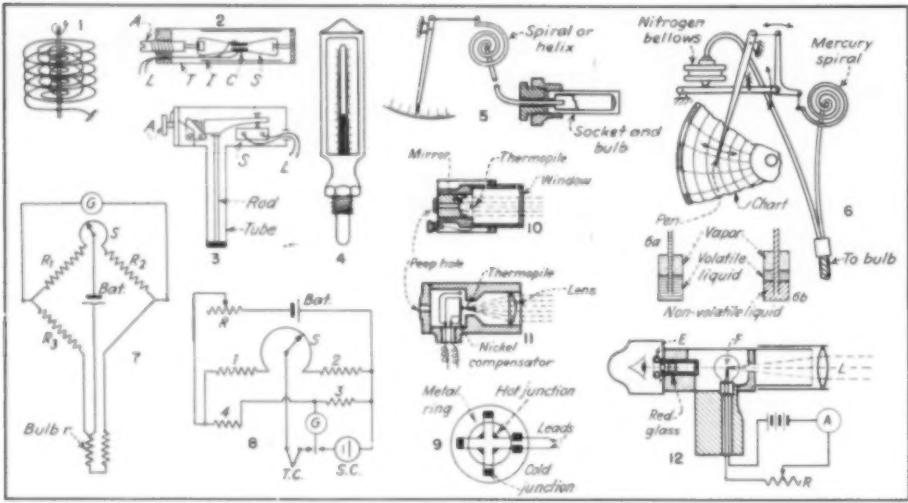
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PROCESS INS

* ACCURACY — Unless otherwise stated, figures for accuracy given here as percent mean that the average expected error will not be more than plus or minus that percentage of full instrument scale. Accuracy figures

are difficult to obtain for many kinds of instruments. In a few cases

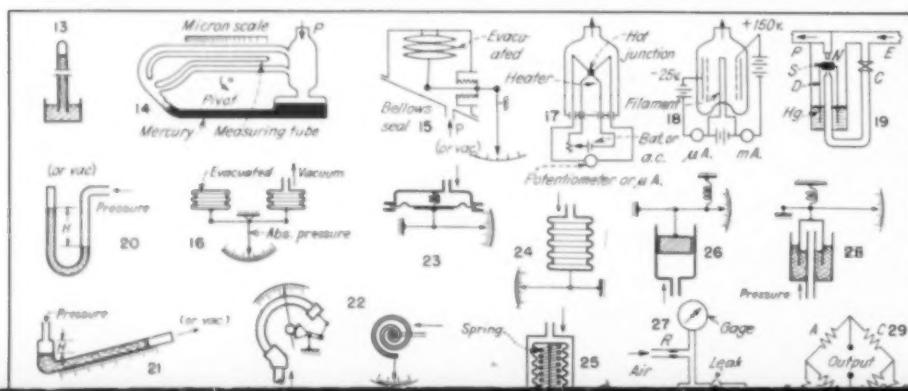
available data. It should be understood that these figures are



Figs. 1-12 — Temperature measuring instruments including thermometers and pyrometers.

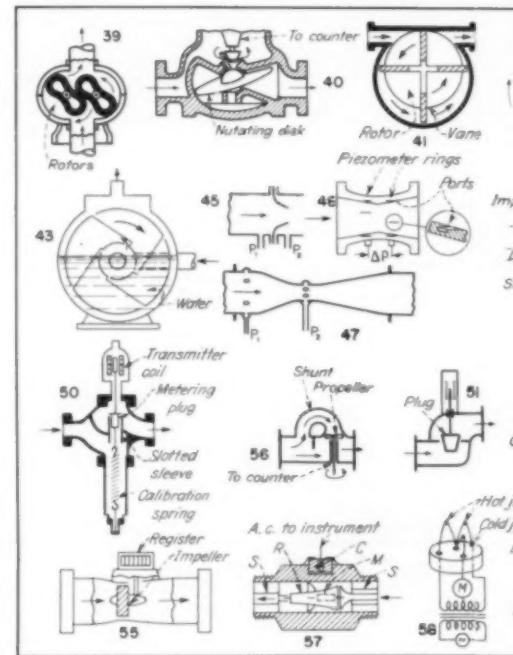
1 — TEMPERATURE

	Principle	Range	Accuracy ^a	Applications and Remarks
(a) Differential	Fig. 1 — (Wells) High-expansion metal strip welded to low-expansion strip deflects on temperature change. If coiled, can rotate shaft and pointer. Extra large deflection can be obtained by using larger diameter strips.	-40 to 100°F. -100 to 1,300°F. Sub-zero to 1,000°F.	Up to 1% Differential less than 0.2% More than 1%.	Simple, rugged, relatively accurate for temperature indication, interchangeable with plain industrial thermometers.
(b) Fluid Expansion	Fig. 2 — (Foucault, Inc.) Contact-acting thermometer has low-expansion strip S carrying contacts C in high-expansion tube T. Bridge circuit regulated by temperature set point A. Open or closes on less than 0.5°F. change.	-38 to 620°F. (Hg), lower limit higher for nitrogen gas. -125 to 1,000°F. with various fills.	Approx. 1%	General temperature control using electric circuit. Fast reaction time, low differential, enclosed assembly. Insulation I gives anti-cold-junction action.
(c) Resistance Thermometers	Fig. 3 — (Bunting Inst. Co.) Bimetallic contact-acting thermometer has low-expansion and in high-expansion tube which moves arm to depress switch S controlling circuit L. Set-point changed by A which moves pivot point of arm.	-125 to 1,000°F.	Up to 1%	General use for industrial temperatures where a record is required. Capillary length can be scaled to distance at distance. Measuring current is 10 milliamperes.
(d) Thermocouples	Fig. 4 — Industrial thermometers use volumetric expansion of mercury or an organic liquid in a glass bulb. In mercurial glass capillary, mercury fill can increase top temperature.	-50 to 600°F., 200°F. top for double-filled. -125 to 1,000°F.	Up to 1% Up to 1%	Gives uniform scale with equal accuracy at all parts of scale. Uses small bulb. Can be supplied with short spans. Capillary error compensation good for 200 ft. or more. General use for indicating, recording and controlling.
(e) Pressure Thermometers	Fig. 5 — Class I pressure type thermometer uses mercury or organic liquid fill in bulb connected by capillary to pressure spiral or bulb (see previous page). Temperature changes of bulb distort pressure element to indicate on scale. Over about 25 ft. of capillary, Class I measures ambient temperature compensation by double capillary system as in Fig. 6.	-32 to 1,200°F.	Less than 1%	Gives high response speed, non-uniform scale, permits up to about 200 ft. of capillary without compensation. Must be calibrated for head of bulb above or below pressure element. General use for indicating, recording and controlling.
(f) Resistance Thermometers	Fig. 6 — (Globe Lab.) Class II pressure type thermometer operates on vapor pressure of a volatile liquid in bulb. Interface must be in bulb with capillary filled with the liquid (except for bulb temperatures below ambient, when capillary is vapor filled). Single-film type (Fig. 7) can take interface. Double-film type (Fig. 8, Bristol) has non-volatile transmitting liquid, interface remains in bulb at all times.	-200 to 1,000°F.	Up to 1%	Has extremely large bulb. Ambient errors small up to 200 ft. of capillary, thus no need for compensation. General use in indicating, recording, controlling.
(g) Radiation Pyrometers	Class III pressure type thermometer has gas fill under pressure in bulb-capillary pressure closed system. Expansion of gas drives pressure element, giving uniform scale.	-125 to 1,000°F.	Up to 1%	General use for indicating, recording and controlling.
(h) Radiation Pyrometers	General: All forms of resistance thermometers operate by measuring in terms of temperature the resistance of an element which changes with temperature. Measurement is ordinarily accomplished with some form of Wheatstone bridge circuit, generally a self-balancing bridge (see Section 29).			
(i) Resistance Thermometers	Fig. 7 — Resistance thermometers are usually a cast of fine wire such as platinum, copper or manganin on an insulating framework of glass, porcelain, or carbon fiber of variable lead resistance. Three-wire lead system is used.	-325 to 1,200°F.	Less than 1%	Used for temperature, temperature difference and temperature gradient measurements. Quoted accuracies, small spans possible. Can be used for highest precision.
(j) Resistance Thermometers	Thermistors, (Bell Labs) These are semiconductor conductors which decrease in resistance with temperature. Can be used for very narrow spans, i.e., 2°C.			Potentially more accurate than thermocouples or resistance thermometers, not yet fully developed.
(k) Thermocouples	General: Thermocouples (thermoelectric pyrometers) operate on the Seebeck effect. When two wires of dissimilar metals are joined at the ends and the junctions maintained at different temperatures, a current flows due to absorption of heat at hot junction. Voltage produced, which is proportional to difference of hot and cold junction temperatures, is measured either by a millivoltmeter or a potentiometer calibrated in terms of temperature of the hot junction for a fixed or compensated cold junction temperature. For potentiometer circuits see Figs. 8 and Section 24. Micro-potentiometer is a null system, balancing T.C. potential against a known potential.			
(l) Thermocouples	Micro-potentiometer. Made of platinum and Pt-13% Rh alloy or Pt-13% Rh alloy for highest temperatures. Top temperature depends on wire gauge. Ordinarily requires protection. Base-metal couples. These types generally used, ordinarily with protection if in higher temperature ranges. (1) Copper-constantan, top temperature 1,000°F., depending on wire gauge. (2) Iron-constantan, top temperature 1,400°F. (3) Chromel-alumel, top temperature 2,300°F.	Top temperature 2,700°F. For compensation use -700°F. to 1000°F. to span, stated.	0.25% Generally about 0.3 to 0.5% depending on span.	Used for high temperatures, and as a standard instrument for calibrating other instruments. Give such higher millivoltages than Pt couples, although slightly lower accuracy. Used for same temperature range as pressure-type thermometers, as well as above and below.
(m) Radiation Pyrometers	Cold junction corrections. Since temperature measured by hot junction depends on a constant cold junction temperature, it is customary to bring the cold junction to the instrument case by use of compensating leads (tubes) if base metal couple is used, or metals with similar thermal expansion coefficients. These include the thermopile (Fig. 9), a group of thermocouples connected in series and vacuum thermopile in which protection is afforded by melting in evacuated glass tube.			Electric characteristics if Pt is used. In the instrument variations are compensated by thermal, or nickel sheet across leads.
(n) Radiation Pyrometers	Fused-focus type. Any radiating black body gives off total radiation that depends only on the temperature. An actual body can be corrected for departure from blackbody conditions. If radiation from a definite area is focused on a thermocouple, the indicated temperature is proportional to the actual. Result of radiation can be made independent of distance between focusing by installing couple at base of long tube containing a concave lens.	200°F. and up.		Used mainly as radiation receivers in radiation pyrometers and special uses where speed or high response is needed.
(o) Optical Pyrometers	Fig. 10 — Focusing type. Similar in principle to fused-focus type except that a lens focuses the radiation onto a thermocouple. Similar to Fig. 10 or a lens (Fig. 11) is used for focusing radiation onto a thermocouple. These two types are used for permanent installations.	200°F. and up.		Its mechanical upper temperature limit, needs no contact with object measured. Can measure temperature of moving objects. Records on millivoltmeter or potentiometer. Readily portable, since focusing is not needed.
(p) Optical Pyrometers	Fig. 12 — Disappearing filament type (Lunds & Nordström). Uses incandescent carbons in resistance bridge circuit, determines intensity in comparison with a heated filament F which disappears at maximum temperature. Filament current is measured in terms of hot object temperature. Filament viewed at E.	1,000 to 5,000°F.	About 1%.	Gives extremely fast response, on firing or cooling objects, at temperatures above range of non-infrared methods.
(q) Optical Pyrometers	Optical wedge type. (Pyrometer Inst. Co.) Similar to disappearing filament type except that target illuminated from calibration lamp of standard current disappears as source intensity is varied by absorption in an optical wedge. Wedge position calibrated as temperature.	1,400 to 3,700°F. Special, 7,000°F.		Musically operated instrument used for indicating, not recording high temperatures. Any high temperature use when hot object can be sighted.
(r) Optical Pyrometers	Wetting point method. Wetting points of pure solids used for thermometer calibration. Also having a wetting point, each liquid has range -70°F. to 6,110°F. for measurement.			Wetting point method. Wetting points of pure solids used for thermometer calibration. Also having a wetting point, each liquid has range -70°F. to 6,110°F. for measurement.
(s) Optical Pyrometers	Pyrometric cones. Calibrated organic cones oxidized as cones available to permit estimation of time-temperature history of fireclay. Used in ceramic manufacture.			Pigment on black paper cover temperature range from 115 to 300°F. Pigment burns, is observed by eye, changing to estimate shades of gray.
(t) Optical Pyrometers	Paper thermometers. (Amy Quartermaster Corps.) Cheap paper strips coated with fusible white wax.			Pigment on black paper cover temperature range from 115 to 300°F. Pigment burns, is observed by eye, changing to estimate shades of gray.



4 — RADIO ACTIVITY MEASUREMENTS (Applications, see Sections 6 to 9)

Giger-Muller counter. Metal cylinder with central grounded electrode, is filled with inert gas such as argon. Window of aluminum foil or non-radioactive plastic or rayon. With electrode charged to 1,000-2,000 V, each particle entering causes ionization, momentary ionization chamber. Similar to Giger but uses low voltage giving smaller current proportions to space charge.
Scintillation counter. Radiation (alpha, beta, gamma and X-rays) and neutrons strike phosphor such as zinc sulfide, give off light flashes detected and amplified by photomultiplier tube.
Atomic battery (Omega Corp.). Generates current direct from beta-gamma radiation, requiring only one vacuum tube for amplification, no high voltage source. Accuracy 2 to 20. Used for dosimeters.
Scalers and pulse counters. Electronic amplifying and registering devices employing trigger circuits to record on lights or mechanical counters, scaling down actual counts by factor of 2 or



Figs. 39-40 — Flow measuring devices including v

5 — FLUID FLOW (Quantity and Rate Meters)

	Principle	Range	Accuracy
(a) Volumetric Meters	Weighing discrete moments. Substitutional tank automatically fills, cuts off at predetermined weight, records on counter, and discards. Cycle time.	Up to 1,000 ft. per min.	
(b) Differential Pressure Meters	Piston meters. Driven by fluid pressure rotates shaft back and forth, recording number of strokes in terms of volume passing. Variations include multiple piston driving wobble plate, double piston in two-cylinder, reciprocating wobble type used for gas. Piston motion operates pellet or turbine-type valves.	Low to medium flow rates.	
(c) Rotating Propeller Meters	Moving paddle wheels. Many types of positive displacement pumps can be used for moving liquids when driven at constant speed. Includes piston-type proportioning pumps, piston-type moving piston pump, gear pump, screw pump, etc.	In air to 100 ft. per sec.	
(d) Rotating Disk Meters	For low, laminar flow. Two-wheel impellers in a close-fit chamber rotated with contact with chamber or each other by action of timing gears. Action similar to a gear pump, liquid or gas carrying around outer ends of chamber.	Up to 1,000 ft. per min.	
(e) Rotating Turbine Meters	Circular disk in a spherical chamber bounded by cones is cut by a vertical partition near discharge port. Space above and below disk turns two separate chambers which propagate waves through to discharge side on disk rotates until equilibrium is reached.	Up to 1,000 ft. per min.	
(f) Rotating Impeller Meters	Impeller carries radial vanes to a discharge port. Impeller rotates by springs against outer casing in fixed seat packets. Fluid pressure rotates drum.	Up to 1,000 ft. per min.	
(g) Rotating Disk Meter	Rotating disk meter. Circular disk in a spherical chamber bounded by cones is cut by a vertical partition near discharge port. Space above and below disk turns two separate chambers which propagate waves through to discharge side on disk rotates until equilibrium is reached.	Up to 1,000 ft. per min.	
(h) Rotating Impeller Meters	Impeller carries radial vanes to a discharge port. Impeller rotates by springs against outer casing in fixed seat packets. Fluid pressure rotates drum.	Up to 1,000 ft. per min.	
(i) Variable Head Meters	General: Variable-head meters produce a differential pressure in the case of closed-chamber meters, or an elevation level below an obstruction in case of open-chamber meters. Results in the first type are therefore measured by various forms of differential pressure measuring device.	Up to 1,000 ft. per min.	
(j) Closed-Orifice Meters	Meters tabulated in this section are rate-of-flow meters. For totalized flow over a period of time they can be provided with integrators or counters which can be programmed. In meters without linear flow-scale correction the integrator supplies the correction by means of a cam, adding units to a counter at equal time intervals in proportion to the average flow rate. A simple method of electronic integration is used in the resistance thermometer (Resistive Flow Meters Co.), shown in Section 26.	Up to 1,000 ft. per min.	
(k) Open-Orifice Meters	Meters for compressible fluids are sometimes automatically corrected for static pressure variation.	Up to 1,000 ft. per min.	
(l) Pitot Tubes	Fig. 44 — Pitot tube. A construction in a pipe line flowing full gives a reproducible and in some cases predictable pressure drop across the constriction for various rates of flow.	Up to 1,000 ft. per min.	
(m) Venturi Tube	Contraction type is the most-used orifice in thin plate. Such orifices are clean and accurate, but may be sensitive to a certain degree of clogging and may be subject to pressure drop due to friction.	Up to 1,000 ft. per min.	
(n) Orifice Meters	Fig. 45 — Orifice meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(o) Venturi Meters	Fig. 46 — Venturi tube. Streamlined differential producer with practically unity flow coefficient, has 20° entrance cone and 5° - 6° discharge cone for maximum pressure recovery. Pressure recovery equals to producer ranges at throat, entrance.	Up to 1,000 ft. per min.	
(p) Nozzles	Fig. 47 — Nozzle. Measures differential pressure across nozzle to determine flow rate.	Up to 1,000 ft. per min.	
(q) Pitot-Orifice Meters	Fig. 48 — Pitot-Orifice meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(r) Pitot-Tube Meters	Fig. 49 — Pitot tube. Flow channels with gradual rather than sharp restrictions as in orifice are called flumes. Flow rates with head of water behind the restriction, compared with bottom height of restriction.	Up to 1,000 ft. per min.	
(s) Venturi-Orifice Meters	Fig. 50 — Venturi-Orifice meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(t) Venturi-Pitot Meters	Fig. 51 — Pitot tube. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(u) Pitot-Flume Meters	Fig. 52 — Pitot-flume meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(v) Pitot-Venturi Meters	Fig. 53 — Pitot-Venturi meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(w) Pitot-Orifice-Venturi Meters	Fig. 54 — Pitot-Orifice-Venturi meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(x) Pitot-Orifice-Venturi-Orifice Meters	Fig. 55 — Pitot-Orifice-Venturi-Orifice meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(y) Pitot-Orifice-Venturi-Orifice-Venturi Meters	Fig. 56 — Pitot-Orifice-Venturi-Orifice-Venturi meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	
(z) Pitot-Orifice-Venturi-Orifice-Venturi-Orifice Meters	Fig. 57 — Pitot-Orifice-Venturi-Orifice-Venturi-Orifice meter. Measures differential pressure across the orifice to determine flow rate.	Up to 1,000 ft. per min.	

GUIDE TO INSTRUMENT ELEMENTS

COMPILED BY THEODORE R. OLIVE

In a few cases the figures have been extracted from best figures are rough and that well designed instruments, well installed and maintained, may give considerably better accuracy, while poorer results may be obtained if the reverse is true.

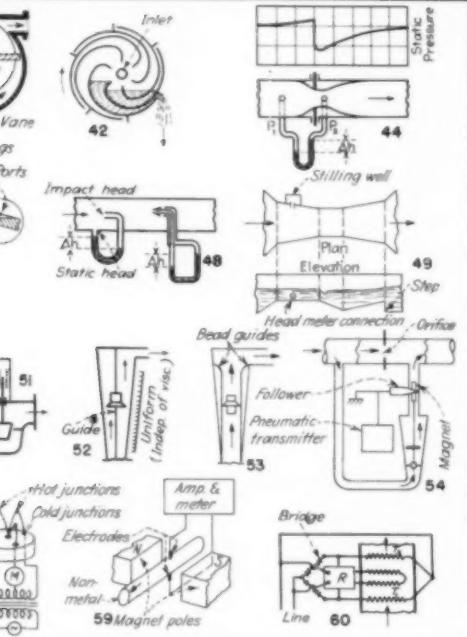
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level gages, or rays, binary counters, photoelectric cells, total radiation received. Used in health monitoring, thickness gages.

Output amplified, fed to pulse counter. Used for general radiation detection and measurement in nuclear laboratories.

measures, level gages.

10. Integrates pulses over a period of time. Also pulse rate meters, used primarily for graphic recording, or printed digital record (Steeeler-Amet).



Figures including volumetric and rate-of-flow meters.

Range	Accuracy*	Applications and Remarks
Up to 1,500 gpm.	High.	Used for batching and for recording of output on semi-continuous basis. Temp. correction not needed. Gives volumetric measure of flow. In some types can correct for variations in density due to temperature. Generally can handle wide range of viscosities. Most commonly used for liquids (except fuel gas turbines). Depending on type can be used to provide accurate rate of liquid delivery either in discrete increments or in continuous flow.
Low to moderate.	High.	Can be used for liquids or gases. Has virtually no clearance except at ends so slip is slight. Used mainly to measure continuous flow. Is suitable for other liquids.
Up to about 1,000 gpm.	Variably depending on clip.	Community used for domestic water metering as well as industrial water metering and totaling of industrial fluids. Often used with vane meter to obtain total shut-off.
1 to 1,000 gpm.	1% or better.	Can be used for liquids or gases. Has virtually no clearance except at ends so slip is slight. Slip increases with low rates, best used at higher rates.
Moderate.	1/2% or better.	Community used for domestic water metering as well as industrial water metering and totaling of industrial fluids. Often used with vane meter to obtain total shut-off.
Wide range from few cfs. to large sizes.	0.5% or better.	Used for metering fuel gas and for calibrating other meters. Pressure drop is low as 0.1 in. w.c.
Moderate. (Low to medium viscosities).	Moderately to high.	Used where discontinuous feed is satisfactory, as in feeding small quantity of rotation requests.

(See Sections 2 and 6) and in the second by level measuring devices (see Section 6). In neither case does flow vary directly with the quantity measured, so that correcting means are often applied to give linear flow scales, e.g., Figs. 32, 35, 36 and 172.

Fig. 172. Height of the mercury column number of resistance elements in series with the transmitter output. Elements are arranged so that current output is directly proportional to flow rate. Hence an electrical power regulator similar to a watt-hour meter can be used to integrate the flow.

Items, or a static pressure pen records simultaneously on the same chart.

High but variable. Orifice characteristics are well known and predictable. Orifices are relatively cheap but have rather high permanent pressure loss. Accuracy depends on care in construction and installation.

Moderate sizes. Good. More expensive than plate orifices, but have lower permanent pressure loss.

Gives negligible permanent pressure loss. Shear and laminar flow are the two extremes of differential methods. Turbulence has little effect.

Used mainly for large flow of water or process fluids. Gives small permanent pressure loss than any other differential products. Handles suspended solids. Simple device, easily installed and capable of use in very large ducts. Since its flow coefficient cannot be predicted accurately, it must be calibrated.

Used mainly for measuring large flows of water, sewage or wastes. Usually constructed on the job.

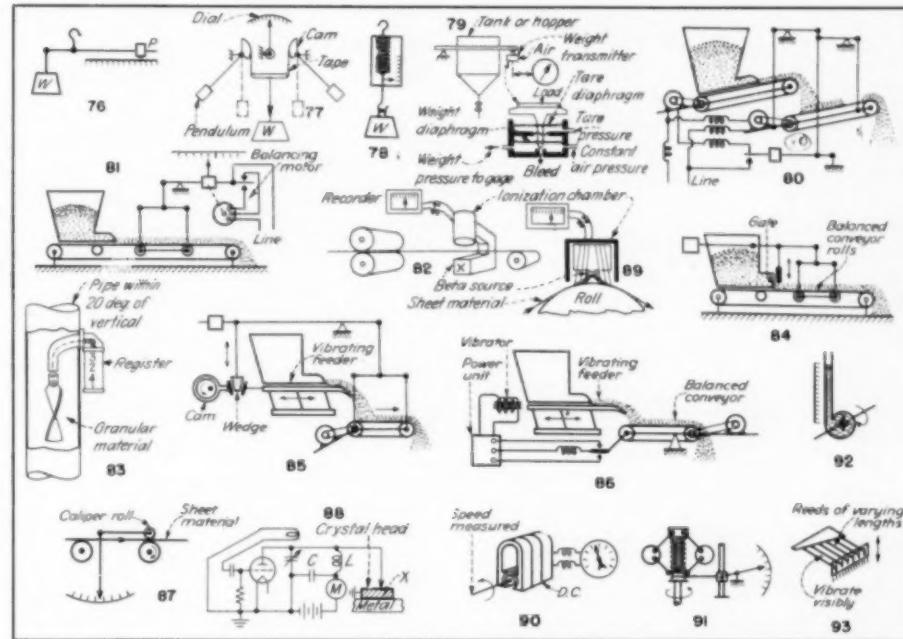
Used mainly for measuring large flows of water, sewage or wastes, constructed from standard dimensions on the job. See Parshall, Trans. ASCE, 1952.

Several methods are used, some of which are affected by variations in viscosity. The common type is the rotameter, which can be designed to viscosity-tolerant.

0 to 4 in. sec. Sensitivity 1%. Used for oils and clear liquids, especially for liquids of relatively high viscosity.

Sensitive to changes in viscosity.

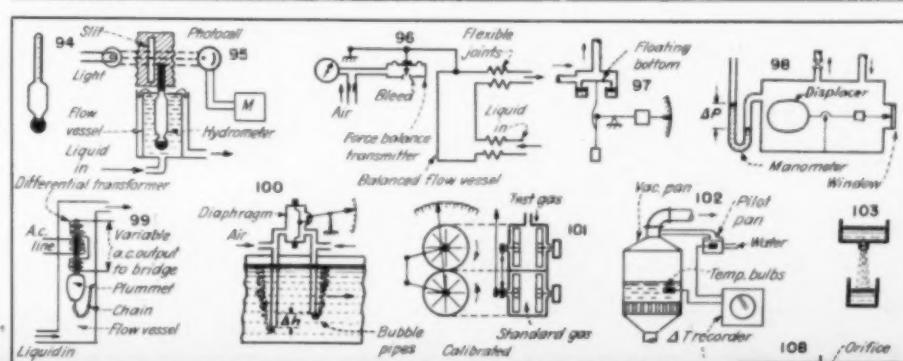
This type can often be suppressed in favor of types with greater tolerances and better responsiveness to viscosity.

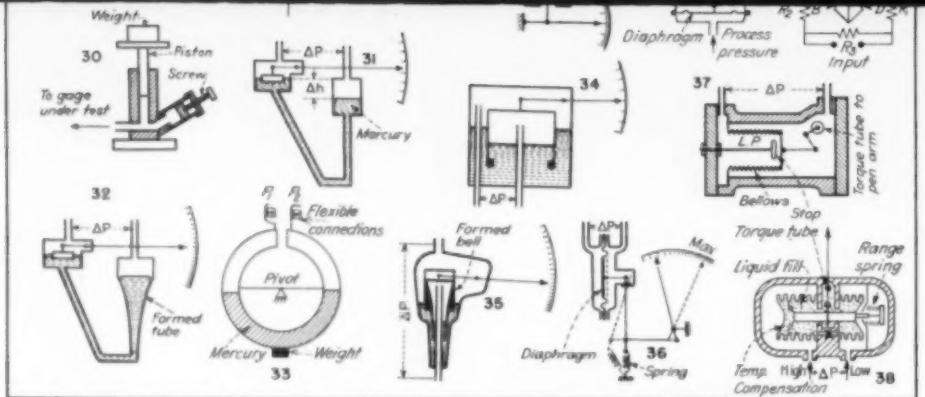


Figs. 76-93 - Devices for measuring weight, weight rate of flow, thickness and speed.

8 - WEIGHT AND WEIGHT RATE OF FLOW

Principle	Range	Accuracy*	Applications and Remarks
Fig. 76 - Univen-balance scale. Simplest form, the steelyard, shown in Fig. 76, illustrates principle of most weight-measuring devices. Unknown weight on a short beam is balanced by a longer beam with known force (or known weights plus force) on long moment arm. Industrial scales (e.g., Fig. 77) introduce additional levers between unknown weight and beam which further increase ratio of unknown to force.	To 400,000 lb. or more.	About 0.1% of actual weight is possible.	Most widely used weighing method for industrial use. Includes manual and automatic types. Indications on dial available. Some types print weight automatically.
Fig. 77 - Pendulum-balanced scale. One or more pendulums balance increasing loads as they move from vertical (zero) to horizontal (maximum). Used to balance various as well as granular materials. Used for grain, coal, etc., in grain elevators. Can be used for grain, coal, etc., in grain elevators.	Same as beam scales since lever reduction can be varied by adjustment of balance mechanism. Generally used for moderate weights.	Commonly used in both commercial and industrial scales, especially where dial indication of weight is desired. Available in analog, digital, printing types, also with automatic cut-off.	
Fig. 78 - Pendulum-balanced scale. One or more pendulums balance increasing loads as they move from vertical (zero) to horizontal (maximum). Used to balance various as well as granular materials. Used for grain, coal, etc., in grain elevators.	Up to 50,000 lb. per load cell.	Commonly used for small commercial scales, but is also used to balance beam in automatic industrial scales indicating automatic weight printers.	
Fig. 79 - Spring-balanced scale. Spring deflection within limits is directly proportional to load, so deflection can be used as a measure of weight supported.	Up to 40 tons.	Used to crane hook scales and other industrial applications.	
Fig. 80 - Hydrometer. Force produced by load is detected by liquid-filled capsule element, transmuted to weight-loading pressure signal and converted to a digital output.	Same as beam scales.	Used for both stationary and moving loads. Easily weight tanks, bins and hoppers. Also also in automatic printing type (Steeeler-Amet).	
Fig. 81 - Semi-continuous load-weighting device (Richardson Scale Co.). Scale-balanced weight cell controls operation of a fixed belt. Scale belt runs continuously but is fed intermittently with material from its full load when an increment of weight is required. Incremental amounts controlled by a variable air pressure proportional to load above tare weight. Constant pressure supply air is lowered in bleed valve to balance load exactly. This pressure is transmitted to indicator.	Up to 50,000 lb. per load cell.	Full balance system gives linear response with net over 0.003 in movement of diaphragm assembly. Needs little space. Used for weight of hoppers, etc., also to measure thrust.	
Fig. 82 - Beta-ray scale (See also Section 9 and 6). (Industrial Nucleonics Corp.). Beta radiation from a strontium-90 source passes through a sheet of material being weighed. Recording is made of a change in weight or thickness. Variation in thickness type where source and ion chamber are on same side of material measured, radiation reflected from a backing plate being measured.	Same as beam scales.	Used to record receipt and withdrawal of bulk materials and for batching of solids.	
Fig. 83 - Vibrating feed tank (Baldwin-Lima-Hamilton Corp.). Scale-balanced beam with bell-shaped load cell supports tank. Scale beam continuously oscillates to indicate weight of material in tank. Scale beam amplitude is proportional to weight of material.	Up to 40 tons.	Used where accuracy of other methods such as volumetric or hand-type flow metering, or pump displacement, is insufficient.	
Fig. 84 - Balanced conveyor scale. Scale-balanced section of belt conveyor used to totally continuous loads in made in many variations. Various forms of automatic weighers used including spring-balanced beams, strain gauge load cells and motor-driven servo self-balancing scales. Totalizer integrates instantaneous loads with belt speed to take care of possible belt speed variations.	Limited only by practical weight tank size.	Commonly used on bulk materials where continuous record is needed for inventory purposes. Such scales give quick response to load variations. See subtract weight of material sticking to return belt.	
Fig. 85 - Vibrating feed tank (Baldwin-Lima-Hamilton Corp.). Scale-balanced beam with bell-shaped load cell supports tank. Scale beam continuously oscillates to indicate weight of material in tank. Scale beam amplitude is proportional to weight of material.	Limited only by conveyor scale available.	Used for continuous measurement of weight per unit area (thickness) of moving webs of sheet materials such as paper, rubber, plastics, coated fabrics, metals. Unaffected by water, surface finish, etc.	
Fig. 86 - Volumetric solids meter (Bailey Meter Co.). Spool valve suspended in a duct containing moving solid material rotates without shift in position to receive material. Connected register receives revolutions in terms of volume or weight passing.	Less than 1% of actual thickness.	Used for continuous weighing of moving webs of sheet material such as rubber, plastics, coated fabrics and other water-free materials.	
Fig. 87 - Scale-balanced belt feed (Schafer-Polyrometer). Scale-balanced feed belt controls setting of load hopper to maintain constant weight on belt. Material on belt is carried on a scale by a mechanically vibrated trough conveyor. Oscillation of trough, controlling feed rate, is governed by pressure of air between oscillating shear and shear attached to trough.	For speed adjustable to 1 cpm. Max. 12 cm.	Device used on spouts not over 30° from vertical. Being volumetric, it must be calibrated on material handled to permit conversion to weight flow.	
Fig. 88 - Balanced belt, electric vibration feed (Cyrus Co., others). Weight of material on a sheet belt is controlled continuously by automatically adjusting the vibration amplitude of an electrically vibrated trough feeder.	Max. 4,000 lb. per ft. load.	Used for handling solids of constant rate to processes.	
Fig. 89 - Weight range.	1% of feed rate.	Used on all types of free-flowing solids for both feeding and proportioning.	





Figs. 13-38 – Pressure measuring instruments for absolute and gage pressure and vacuum, and differential pressure.

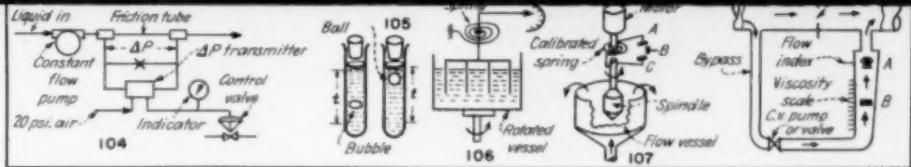
2 - PRESSURE (Absolute, Gage, Vacuum, Draft, Differential)

	Principle	Range	Accuracy*	Applications and Remarks:
	Fig. 13 - Liquid column barometer. The fundamental instrument for measuring pressure of the atmosphere. Glass tube, closed at one end and filled with mercury, is inverted in a vessel of mercury. Height of Mg column above vessel level is the barometric pressure in mm. (Vg = 13.6 g/cm ³ , $\rho_{Hg} = 13.6 \times 10^3$ kg/m ³ , $g = 9.81 \text{ m/sec}^2$)	Any pressure of atmosphere.	Roughly 0.1 mm.	Although less convenient than the aneroid type, the Hg barometer is used for precise measurements and for calibration of other instruments.
	Fig. 14 - McLeod gauge (F. S. Woods Mech. Co., modifications). Gas at low absolute pressure is trapped in measuring tube by mercury as instrument rotates about a pivot through 90° from horizontal. Mercury compresses gas into top of measuring tube were final volume, expressed as initial absolute pressure, is read.	1 to 5,000 micron.		Used as primary standard for absolute pressures in excess of 0.001 mm. Range requires trapping of condensables to avoid error. Can be calibrated, though usually unoperated.
	Fig. 15 - Single-bellows absolute pressure gauge (Bristol). Single evacuated bellows enters vertical tube. Movement of piston through bellows seal indicates pressure.	0 to 200 mm Hg.	High accuracy is claimed.	Can be supplied to spans as low as 0 to 6 mm. Hg for vacuum, steam condensers, vacuum stoves, automotive pressure.
	Fig. 16 - Two-bellows absolute pressure gauge. Made with either opposed or telescopic bellows, one bellows extended, often expanded to pressure measured.	0 to 25 psi.	1% or better.	Considered accurate for pressures down to about 5 mm. Hg. Used similar to above.
	Fig. 17 - Thermocouple gauge. Inferential type which measures thermal conductivity of gas at reduced pressure in terms of pressure. Temperature of heating filament is detected by thermocouple, usually by potentiometer or millivoltmeter.	1 to 2500 micron. (Some to 1,000,000 micron.)		Easy to use but must be calibrated on type of gas to be measured. Extends measurement below field of bellows seals.
	Fig. 18 - Ionization gauge. Measures ion current produced by ionization of gas except that filament temperature is measured as a resistance thermometer in Wheatstone bridge.	1 to 3,000 micron.		Features similar to thermocouple gauge. Used similar, above range of ionization gauge.
	Fig. 19 - Hot-filament ionization gauge. Uses three-element ion tube containing low pressure gas to be measured. Molecules ionized by electrons from filament flow to plate, discharge, yield total current proportional to ionizable material.	0.001 to 1 micron.		Suitable for low absolute pressures but must be protected vs. bareness of pressure gases above 1 micron. Useful for vacuum, steam condensers, vacuum stoves, etc.
	Fig. 20 - Alpha-particle ionization gauge. Similar to hot-filament type except that ionization is caused by alpha particles from a radioactive source.	0 to 10,000 microns.	1%.	No filament, there is no bare metal, so alpha ionization gauge can be used for pressures well above 1 micron. Unaffected by kind of gas.
	Fig. 21 - Capacitance absolute pressure control (Emi Gerber). Desired vacuum is set inside probe D by opening valve C comparable to system E. Thereafter D closes seal against nozzle N connecting to probe A until system pressure rises.	Holds pressures from 1 mm. to 10 psi.	0.1% of set point.	Simple device maintains desired absolute pressure or vacuum. Made in glass or metal. Readily reset to other control pressures.
	Fig. 22 - Bellows-type pressure-detecting units. Tube of flattened cross-section, an incomplete circle (conventional location), split at one end, holds to straighten with pressure increase. May be calibrated to yield by cal or gauging.	About 2 m. of liquid head.	0.01 in. of manometer liquid.	More accurate but limited by glass construction and available column height. Used chiefly for large gas drafts and pressures where visual indication is sufficient.
	Fig. 23 - Inclined draft gauge. Similar to U-tube but has one inclined leg vs. large diameter well to increase reading accuracy.	0 to 10,000 psia or higher.	Better than 0.01 in. of liquid.	Most indicating gages use conventional manometer. Simple, reliable and usually accurate. Can type calibrated. Gage may be calibrated to yield.
	Fig. 24 - Bellows-type pressure-detecting units. Tube of flattened cross-section, an incomplete circle (conventional location), split at one end, holds to straighten with pressure increase. May be calibrated to yield by cal or gauging.	0 to 120 in. w.c.	1%.	Used especially for low pressure and draft such as 0 to 0.5 in. w.c., in both indicators and recorders.
	Fig. 25 - Slack diaphragm gage. Slack diaphragm is balanced by pressure or tension of a calibrated spring.	Vac. to about 100 psi.	± 5 to 10%.	Simple and rugged, widely used in moderate-pressure and vacuum instruments, especially in recorders.
	Fig. 26 - Pressure gage. Except for friction, comparable to slack diaphragm. Pressure is balanced by a calibrated spring.	Vac. to high, depending on spring.	1%.	Used mainly for study of pressure cycles as in the steam engine indicator. Operates slowly, records.
	Fig. 27 - Gage pressure gage (Ward Brattain). Pressure applied applied to a force-balanced bellows. Bellows deflection is applied to a strain gauge. Reaction force in air capsule and load controlled by diaphragm exactly duplicate pressure.	Vac. to 10,000 psia or higher.		Used in corrosive chemical applications with diaphragm sealed to resist acid, alkali or caustics, or those which might set up in gage. Generally are cleanable.
	Fig. 28 - Load-balanced bellows. Bellows held deft into liquid which acts merely as a seal. Bell is balanced by a calibrated spring.	Relax.	1%.	Can be used as gage to protect against corrosive, viscous, dirty or radioactive fluids, or can transmit readings up to 1,000 psi.
	Fig. 29 - Stress gauge (Bell-Brown-Lyon-Hamilton Corp.). Uses small resistance element wound on an coil. Resistor is balanced by strain gauge. Small increase in resistance is converted to stress. Used methods equivalent to Wheatstone bridge so that resistances A and D are strained, B and C are not. Other resistances are provided for temperature compensation and calibration.	Vac. to about 15 in. w.c.	1% or better.	Used for low pressures and vacuums, can be made extremely sensitive.
	Fig. 30 - Differential test type of pressure gage in which first pressure in balanced against known weight applied to known area of capsule. Pressure applied by secondary pressure source, usually air, is balanced by a weight. Used to zero gage.	Unloaded.	1% or better.	Relatively new method becoming popular, especially in high pressure ranges. Good transmission to millivoltmeter or potentiometer indicates recorder, good linearity and reproducibility, negligible hysteresis, quick response. Unbonded types also used.
	Fig. 31 - Gravity-balanced pressure (Barlow-Miner Co.). Weight-balanced pressure-measuring position supports a cap holding mercury. Increased pressure raises position, position related to lower displacer into mercury, forcing piston back to neutral position. Position of displacer is measure of pressure and can easily be telemeasured.	Unloaded.	0.1%.	Used as primary standard for calibration of gages.
	Fig. 32 - General. A large part of all flow measurement (Section 5) is accomplished with variable-head producers, such as orifices, requiring differential pressure measurement for indication and recording. Most of the gage pressure methods above can be adapted for such measurement. Since flow through closed-channel head produces varies as the square root of the differential pressure, many differential pressure gages are compensated for the square root relation to give a uniform scale on flow. If calibrated on differential, such devices have an inverse square root scale, e.g., Figs. 32 and 33.			Adapted to narrow-space requirements at relatively high pressures. Built-in Saftey valve provides for relatively long transmission.
	Fig. 33 - Glass liquid column manometers, identical with those in Section 2(b) except that the two pressures are connected, one in each end of the tube.	Differentials of 10 in. w.c. max. to 400 in. or higher.	About 0.01 in. of manometer liquid.	Simple and accurate but limited by glass construction and available column height. Limited static pressure, cannot indicate positive pressure, transmits flow, etc.
	Fig. 34 - Water manometer, water tube. Used instead of mercury, is read by comparing with water methods. Used for low pressure, temperature or magnetic float.	About 10 in. w.c. max.	1%.	Also for differential-pressure level and density measurements. Static pressures to 5,000 psi.
	Fig. 35 - Metal manometers, liquid tube. Similar to glass tube except that range is limited to variable parabolic curve section to extract square root for flow.	About 10 in. w.c. max.	1 - 2%.	Not commonly used owing to expense of accurately forming range tube. Gives uniform scale for flow.
	Fig. 36 - Tilted manometer. Manometer balanced on knife edge, and connected by flexible leads to pressure sources. Tilts in proportion to differential. Use of can and counterweight (Gardner Denver Co.).	0.2 to 12 in. w.c.	1%.	Used for general rate-of-flow measurement. Averts need for pressure-light staff.
	Fig. 37 - Resistive balance manometer. Similar in principle to tilting manometer. Split rubber ring with flexible arms rotates about central knife edge, balanced by a weight at the bottom.	Very low range.	1%.	Used for general rate-of-flow measurement. Averts need for pressure-light staff.
	Fig. 38 - Floating bell, single. Similar to single-pressure bell (Section 2(c)) except optimized for application of pressure to both seals, their position proportional to differential, can be read by eye, can be read directly or projected onto a scale.	212 in. w.c. max. differential.	Large one of bell gives ample power for operating recording mechanism at very low differentials.	
	Fig. 39 - Floating bell (Barlow-Lyon Bell). Bell shaped internally to parabolic form extracts square root of differential to give uniform scale on flow. Ng seal.	Ths. 2 to max. 14 in. w.c. differential.	Can be made very right for extremely low differentials, e.g., for low flow rates of gases.	
	Fig. 40 - Floating bell with demand balance (Barlow-Lyon Water Co.). Demand balance inside and supported by bell itself, reads to square root of total sum of pressure for square root correction.	Ths. 0.2 to max. 120 in. w.c. differential.	Used in general rate-of-flow metering. Uniform scale facilitates reading and integrating.	
	Fig. 41 - Stacking bell. Similar to single-pressure type and can be built with bell sets of diaphragms and bellows to give square root of total pressure.	Ths. 0.2 to max. 120 in. w.c. differential.	Gives uniform scale for flow for low range.	
	Fig. 42 - Stack diaphragm, volume-rate compensating (Hays Corp.). Addition of cantilever spring in line with motion of area (see sketch) extracts square root of flow.	Ths. 25 to max. 300 in. w.c. differential.	Suitable for very low differentials, e.g., flow rates of gases. Located static pressure.	
	Fig. 43 - Bellows differential gauge, single tube (Hays Corp.). Diaphragm on casing is subjected to low pressure on one side, high on the other. Bellows extension measures differential pressure. Can be calibrated with various types of gauges.	Ths. 15 to max. 300 in. w.c. differential.	Used for low differential for flow where uniformly divided scale is desired.	
	Fig. 44 - Differential pressure gage (Hays Corp.). Opened bellows are fitted with bellows, balanced by a shaft passing through a restriction. Arrangement acts like spring-balanced piston with high pressure at one end, low at other. Pistons balanced by spring controlling liquid flow from one bellows to other. Temperature compensation for liquid density is provided by floating bellows sections.	0.5% of full differential.	Simple, rugged, range easily changed, requires no necessary maintenance. General differential pressure gage.	
	Fig. 45 - Differential pressure gage (Hays Corp.). Motion of bellows heated by a.c. is caused by thermal conductivity to give measure of flow. Does not measure pressure and is not affected by a transducer, although so called and rated.	Equivalent to differentials of 0.001 to 0.01 to 0.1 in. w.c.	Some, equiv. to diff. of 2,000/1 in. w.c.	Unbalanced by over-range. Range easily adjusted. No recorder. Eliminates poration. Torque tube for transmitting motion eliminates possible leakage.

J - FORCE, TENSION, COMPRESSION

Principle	Range	Accuracy*	Applications and Remarks
Fuid pressure-sensing systems. Most pressure measuring systems in Section 2 can be used for force measurement. Particularly these include spring-balanced devices of Section 2(c). Differential pressure sensors can be used to measure the force of two elastic elements coupled by tubing, with the system liquid-filled. Force at one end is transmitted to the other and indicated there as a deflection. Transmitter is usually a stiff spring unit, receives a biaxial input.	Unlimited	1% of fullfill	Units require calibration but can be rugged and dependable. Indication can be transmitted over several hundred feet.
Prismatic force balance. Force-balance systems as in Section 2(b) or Fig. 27 balance a fixed mass against a variable mass that reacts prismatic pressure on the other, transmitting other pressure to a pressure indicator.	Moderate force magnitudes.	0.5% or better.	Useful where a null system with virtually no displacement of the measuring diaphragm is desired.
Fig. 29 - Bonded strain gages. (See Section 2c) Same strain gauge units used for measuring elongation (strain) of pressurized structural element can be used to measure strains produced by tension, compression, angle, etc. Four resistance elements in a bridge circuit, or two more (a unity for temperature compensation) are bonded to stressed surface and resistance changes measured.	Unlimited.	Strains as small as 0.000001 in./in. can be measured.	Strain gages mounted on paper, fabric or plastic can be bonded to stressed surface by cement, or lead measuring units incorporating already-bonded gages are available for measuring weight, force, deflection, stress load, etc.
Unbonded strain gages. Unit consists of two rapid frames joined with four calibrated resistance elements in bridge circuit. Strain tension to pull frame members apart increases strain in one pair, reduces strain in second pair of elements.	Forces to about 4 lb. for displacements to about 0.002 in.	Lens used than biaxial type. Affairs easy method of measuring small strains from 1/16 in. to 4 in., or for building into instruments. Temperature compensated.	
Tension gage. Metal stretching on uniaxial span of moving sheet material can be used to measure tension in uniaxial, either deflection for constant load, or load for constant deflection being measured.		Must be calibrated, calibration depending on unapplied tension. Easily adapted to control by maintaining constant tension.	
Damage gage. Roll carried by vertical loop of moving sheet material measures tension by vertical displacement. Part of roll weight usually counterbalanced.		Easily adapted to automatic control through contact or point devices for synchronizing roll speeds.	

1 to 4 in. diam.	% to 2%	Used where visual reading of float level is impractical (liquids or gases) or where transmission is required. Permits use of viscosity-measure meters. Used for stability of flow in viscometer meters. Enables viscosity-measure tools to be used without meter guide.
4 in. max.	% to 2%	Used only by size of main line from which bypass flow is taken.
Large.		Permits use of variable area meters in much larger sizes than are practical with glass tapered tubes.
		Used mainly for wind velocity rather than flow rate.
20 to 24,000 fpm.	2%	Used mainly in heating, ventilating, air conditioning and exhaust system design, installation and maintenance.
2 to 36 in. pipe size.	2% of actual flow.	Gives low pressure drop. Used for liquids only. Can stand high temperature overloads. Substitutes orifice flow. Used for steam, gas or air only (no liquids). Easy to install, change orifice for capacity change. Magnetic counter drive eliminates staffing loss.
1 to 4 in. main pipe size.	2%	Elimination of end thrust said to give high accuracy. Meter has little pressure drop, good for high static pressures.
3/8 to 36 in. pipe size.		
0 to 6,000 fpm. air speed.	10%	Used mainly as a directional or non-directional air velocity meter but can be enclosed (Section 2g) for use as a flow meter. No pressure drop except straight line loss. Accuracy unaffected by pressure, viscosity, density or character of fluid. Response linear with flow rate. Liquid must be slightly conducting.
Theoretically unlimited.	% to 2%	Used in gas metering for large flows. Another type (Engelhard) available for liquid metering.



Figs. 94-108 - Instruments for measuring liquid and gas density and liquid viscosity.

9 - THICKNESS AND DISPLACEMENT

Principle		Range	Accuracy*	Applications and Remarks
		Usual thicknesses of sheet materials.	Variable depending on construction.	Suitable for moving webs of sheet materials where physical contact will not be harmful.
		Usual thicknesses of sheet materials.	High.	Variations of this system have advantage that physical contact with moving web is not required.
		1/16 to 12 in. metal thickness.	2% or better.	Calibrated from known thickness of material to be measured. Can determine thickness of pipes, vessels, etc., where outer surface is not available. Used in checking for corrosion.
		Usual range of pipe and vessel thicknesses.	2% or better.	Calibrated against standard thicknesses. Used for determining limits due to corrosion in pipe and vessels.
		Usual thicknesses of sheet materials.	1-2% or better.	Used for continuous thickness measurements on moving webs of sheet materials such as paper, rubber, plastics, composites, metals. Unaffected by water, surface finishes, etc.
		Usual thickness of sheet materials.	High.	Used specifically for tin plate.
		Usual thicknesses of sheet materials.	10% or better.	Used for continuous thickness measurement on moving webs of sheet materials such as rubber, plastics.

10 - VELOCITY (Linear and Angular)

Principle		Range	Accuracy*	Applications and Remarks
Aio - wave indicators. Include such devices as cap and wave anemometers (Section 3e), tail-wave anemometers (Section 3f) and probe table (Section 3h).		Various.	Various.	Used in meteorology, flight, air conditioning and ventilation.
Conversion of linear to angular velocity. Speed of moving surfaces such as moving web or surface of drum or roll can be measured by contact with a wheel of known circumference or determination of wheel speed by a tachometer.		Up to about 15,000 rpm.	Up to about 1%.	Used for measuring output of processes producing web materials.
Fig. 60 - Ultrasonic resonance gauge (Ultrasonic Instruments). Ultrasonic wave from a crystal held in contact with test material passes through material, reflects back to head. When round trip time equals vibration frequency, resonance is attained, causing increase in circuit power. Frequency set by adjusting values of L and C. Point of maximum energy absorption determines from microammeter M.		0 to 4,000 rpm.	About 4%.	Commercial industrial rotational speed device. For speeds beyond its range can easily be gravitated. Needs less resistance than d.c. tachometers since it has no commutator or brushes.
Fig. 61 - D.C. magnetometer (General Electric Co., others). Principle same as described in Section 6b where either absorption or back-scattering of beta rays by moving web of sheet material is measured. Used for continuous thickness measurement. Method shown in Fig. 60 is back-scattering (North American Philips Co.). X-ray beam set at 70° from surface of moving sheet of tin plate produces secondary radiation from steel backing which is back-scattered to Geiger tube. Intensity of secondary radiation is a function of tin plate thickness. Duplicate units on both sides page both surfaces.		0 to 2,000 rpm.	Up to 10%.	Little used industrially.
X-ray back-scattering (General Electric Co.). X-ray beam passes through material to be measured to surface detector. Decrease in intensity measured as thickness.		Up to about 40,000 rpm.	10% or better.	Used chiefly for speed regulation rather than measurement, although indicating devices using centrifugal forces in other forms are not uncommon. Not much used industrially.
Dielectric constant (Fotron Co.). Same as dielectric constant weighing method described in Section 9. Meter calibrated in thickness rather than weight.		600 to 100,000 rpm.	0.5% of actual frequency or better.	Capable of measuring very high vibration frequencies. Needs contact only with a non-moving part of rotating machine. Each instrument has relatively limited range.
Fig. 92 - Velocity head meters. Small centrifugal pumps and blowers deliver an output to a manometer or gage where velocity head is converted to static pressure. Calibrated in terms of a manometer or gage pressure.		Unlimited, by use of harmonics.	Synchronization perfect.	Main use in experimental work, trouble shooting.
Fig. 93 - Vibration head meters. Small centrifugal pumps and blowers deliver an output to a manometer or gage where velocity head is converted to static pressure. Calibrated in terms of a manometer or gage pressure.				
Stroboscopes. For measurement of rotational speed or other cyclic movement, stroboscopes can be used to reveal motion. Speed of the stroboscope (rotary or linear) is varied to synchronize the motion object to be viewed once per cycle, as with a rotating shutter or flashing light from a gas-discharge lamp.				

11 - FLUID DENSITY AND SPECIFIC GRAVITY

Principle		Range	Accuracy*	Applications and Remarks
Fig. 94 - Hand hydrometer. Weighted float with small diameter stem at top sinks in liquid but floats in water. Weight of float is proportional to density of liquid.		Adaptable to any specific gravity.	Third or fourth decimal place.	Widely used where automatic operation is not needed. For viscosity readings, hydrometer can be used to a limited extent. Used for oil viscosity.
Fig. 95 - Photoelectric hydrometer (E-Es Instrument Co.). Glass hydrometer in continuous flow vessel has opaque stem which rises or falls in head of a test. Illumination on one side of stem passes through, falls in photodiode, gives position determines amount of light passing, hence output of photocell which is recorded.		Any specific gravity of liquids.	Second or third decimal place.	Similar to but more convenient than two-pipe system described above. Suitable for any gas. Can be made recording. Used mainly for high-precision laboratory measurements. Cannot be adapted to continuous measurement.
Fig. 96 - Balance beam. Weighted float in vessel through which liquid flows continuously to balance by weight of float against balance beam in vessel. Can be open vessel or closed vessel with flexible connections.		Any density of gases.	High.	Generally applicable to automatic density control.
Fig. 97 - Glass specific gravity balance (Alfa-Laval). Weight of tall gas column is measured against air by floating bottom of gas vessel, which is scale-balanced.		Fourth decimal place.	High.	Similar to but more convenient than two-pipe system described above. Suitable for any gas. Can be made recording. Used mainly for high-precision laboratory measurements. Cannot be adapted to continuous measurement.
Fig. 98 - Differential pressure density meter (Precision Thermometer & Instrument Co.). Weighted float in vessel is suspended to carry half the weight of a light chain when submerged in medium density liquid at midpoint in its range. Chain is tensioned in bottom of float and to vessel wall at half height. Density increases causes float to rise, supporting more chain, decrease, to sink, supporting less chain. Float rotates on cone. Position transmitter is recorded by inductance pickup of three-winding differential transformer type (See Section 25c).		Any liquid density.	Second or third decimal place.	Widely used method for industrial recording and control of liquid density.
Fig. 99 - Differential pressure density meter (Precision Thermometer & Instrument Co.). Weighted float in vessel is suspended to carry half the weight of a light chain when submerged in medium density liquid at midpoint in its range. Chain is tensioned in bottom of float and to vessel wall at half height. Density increases causes float to rise, supporting more chain, decrease, to sink, supporting less chain. Float rotates on cone. Position transmitter is recorded by inductance pickup of three-winding differential transformer type (See Section 25c).		Liquid gravity range, 0.6 to 1.3 sp. gr.	High.	Can be used for recording and/or control. Available to resist most corrosive conditions. Suitable for practically any liquid. Note this is a method of actually weighing liquid volume of liquid. Can be corrected for temperature variations.
Fig. 100 - Viscosity-density density meter (Permitco Type, Permitco Co.). Driven impeller in standard test gas chamber, float carries weight equal to weight of gas column. Resistance of float to rotation is measured by linkage. Relative drag shown is tendency to rotate, balance point depending on relative density.		Any liquid density.	About 0.3 to 1%.	Suitable for practically all liquids except those which will crystallize in the measuring pipes. Can be used on suspensions, on stationary or flowing liquids. Can use liquid instead of air.
Fig. 101 - Rotating float density meter (Rheo-Rite Type, Permco Type, Permitco Co.). Driven impeller in standard test gas chamber, float carries weight equal to weight of gas column. Resistance of float to rotation is measured by linkage. Relative drag shown is tendency to rotate, balance point depending on relative density.		Usual industrial gases.	About 0.01 sp. gr.	Often used for determining composition of binary gas mixtures - an analysis rather than a density instrument. Calibrated on gases to be measured.
Fig. 102 - Spinning float elevation. Compares temperature of boiling solution with that of water boiling at same pressure. For particular solution, boiling point elevation can be calculated in terms of density at standard temperature.		One dissolved component or mixture of fixed compositions.	High.	METHOD USED IN EVAPORATORS FOR DETERMINING END-POINT OF CONCENTRATION. Commonly uses resistance thermometers to record difference in the two temperatures.

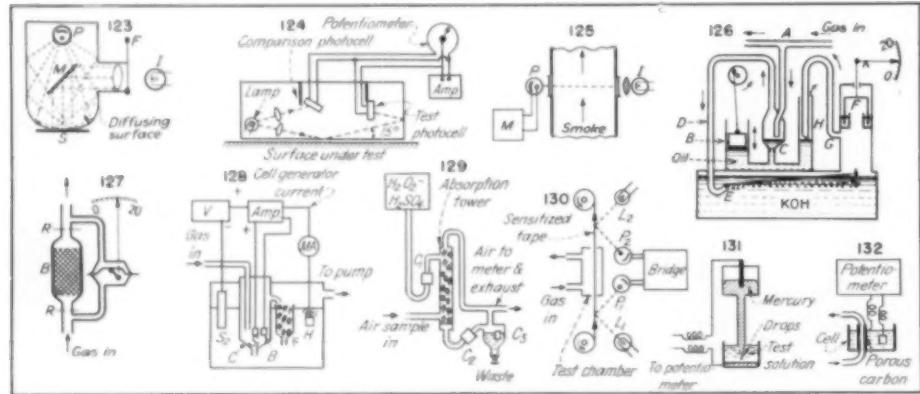
12 - VISCOSITY AND CONSISTENCY

Principle		Range	Accuracy*	Applications and Remarks
Fig. 103 - Timed discharge through nozzle. Method of viscometers such as the Sestoft. Vessel with short capillary tube in bottom filled with liquid to definite height at desired temperature. Efflux under gravity head is timed, viscosity is expressed as seconds. Result can be converted to absolute viscosity by multiplying by factor of 0.001.		Low to moderately high.	High.	Commonly used for expressing viscosities of oils.
Fig. 104 - Timed discharge through friction tube. Liquid pumped at constant rate through friction tube. Pressure drop across ends of tube is measured by pneumatic force-balance type differential pressure transmitter in terms of absolute viscosity. Gives direct result to Poiseuille's equation.		Up to 3,000 cp.	0.2 cp. in span of 50 cp.	Can be used for wide range of industrial liquids, for density recording and control. Extremely simple and inexpensive. Requires no attention.
Fig. 105 - Drag torque on stationary element in rotated cap. Some types use a cylinder, others a paddle as spinner (Brodbeck). Liquid cap rotates at constant speed, stationary element is restrained by calibrated spring which, by angular displacement, measures torque in terms of viscosity.		Used primarily for high viscosities.	High.	Both are laboratory methods commonly used in measuring oil viscosity. Both need cap to be fitted with great accuracy. Both can be used for density.
Fig. 106 - Timed fall of ball in tube. Time for fall of metal ball or rate of bubble through liquid in vessel is measured to determine viscosity in terms of absolute viscosity.		0.2 to 200,000 cp.	About 1%.	Used for recording and either manual or automatic control in paints, oils, soaps, plastics and similar uses. Incorporates high-low viscosity alarms.
Fig. 107 - Torque to rotate a torque element in a liquid (Brookfield Fig. Co.). Sensitive motor drives vertical spindle with disk, paddle or cylinder submerged in test liquid. Drive is through calibrated spring. Angular lag of spindle behind motor is proportional to viscosity and is measured in various ways. Controller detects angle of displacement by periodic electric contact. Recorders adjust the time deviation by setting the instrument and measure angle three ways: capacity change, resistance change, time required. Best calibrated shows measure time lag of rotating contact C behind A by stationary contact R.		Up to 400 centistokes, span type to 1,000,000 cp.	1 to 2%.	Precisely a laboratory instrument but may be equipped to record. Brookfield is often surrounded by thermostatic housing for close temperature control.
Fig. 108 - Viscosity-sensitive rotameter (Fotron & Porter Co.). Rotameter tube can be designed for either sensitivity or immunity to viscosity. With constant flow rate, viscosity can be calibrated for viscosity. One method is to use rotameter tool to set flow rate at some constant value, then move tube shows viscosity. Other methods include one of constant flow regulator operated separately or from rotameter tool, constant volume pump to hold flow rate constant.		To 50,000 cp. a sec.	High.	Can be used in open or closed vessels, under pressure or vacuum, at high or low temperatures. Used for both Newtonian and non-Newtonian liquids or suspensions.
Ultrasonic probe (Rich-Radi Labs). Ultrasonically vibrated probe in tank or flow line measures viscosity in terms of energy required to drive the probe. Electronic computer measures product of cp. a sec. and μ . Gives instantaneous reading on single- or multi-point recorder at distances up to 1 m.		Non-Newtonian suspensions of fairly high consistency.	High.	Suitable for both Newtonian and non-Newtonian liquids and suspensions in continuous flow. Used for visual and remote readings and control.
Fig. 109 - Viscosity-sensitive rotameter (Fotron & Porter Co.). Rotameter tube can be designed for either sensitivity or immunity to viscosity. With constant flow rate, viscosity can be calibrated for viscosity. One method is to use rotameter tool to set flow rate at some constant value, then move tube shows viscosity. Other methods include one of constant flow regulator operated separately or from rotameter tool, constant volume pump to hold flow rate constant.		High.	New method for all types of viscosity recording and control. Used for both Newtonian and non-Newtonian liquids and suspensions. Wide temperature and pressure range; automatic temperature compensation if desired. Used in paper industry.	

<p>(i) Hygrometers</p> <p>Bridge circuitry, also for wet-bulb. Use two dry-bulbs. If moist temperatures are plotted against ambient temperature, it is found that they fall on a constant R.H. line through the origin, but all combinations on this line are same R.H. Hence encoder compares measurements, finds which line they fall on and indicates result as R.H.</p> <p>Fig. 119 - Differential-charge hygrometers. Various organic materials change in linear (or almost) dimensions with changes in relative humidity. Among them are human hair, which makes one of the most accurate hygrometers; various woods, animal bones, brasses, etc. The principle is to make a scale and calibrate it by a thermometric hygrometer (Fig. 118), making a simple direct-reading indicator.</p> <p>Fig. 120 - Electric resistance hygrometers (Baldwin, and others). Developed originally by NBS, now made by several. Double wire winding on light insulation is coated with hygroscopic film containing lithium chloride which becomes more conductive as its equilibrium moisture content increases. Ambient humidity determines conductivity of coating and thus governs current flow between the wires. A.c. may be used, measured as d.c. by rectifying stage. As resistance of element can be measured in a Wheatstone bridge circuit, no adjustment or calibration for temperature.</p> <p>Fig. 121 - Micro-type dewpoint recorder (General Electric Co., others). Warmer M is coated with flowing wax is cooled to condense vapor. Light passing through duct O from source I to photocell P is reduced as dew forms. When a certain H is evaporate away. When again increases, refrigeration R causes heat, repeating cycle. Temperature shows peaks and valleys, the valleys being dewpoint temperature. Only valleys are recorded.</p> <p>Fig. 122 - Electric hygrometer-type dewpoint meter (Frigidaire Co.). Superficially similar to Fig. 120 but works on different principle. Double resistance wire wound on insulating tube is coated with hygroscopic material containing lithium chloride. Inside the tube is a thermometer bulb. Low voltage current supplied to wires heats the coating, thereby driving out moisture until equilibrium is reached between moisture leaving and moisture returning. Temperature of the evaporation point as measured by the thermometer is related to dewpoint of air at bulb and is so calibrated on recorder.</p>	<p>25 to 90%.</p> <p>7% in best units, generally rather poor.</p> <p>Advantage is direct reading of R.H. Since response and somewhat temperature sensitive.</p> <p>25 to 95% R.H., 50 to 120° dry-bulb.</p> <p>1.5% or better.</p> <p>Rapid response and good accuracy are main advantages.</p> <p>From 110° F. to -100° F.</p> <p>3° F.</p> <p>Can measure extremely low dewpoints and so is used chiefly for determining moisture content of refrigerated goods.</p> <p>Dewpoints of -50 to 140° F. at ambient's to 220° F.</p> <p>140° C.</p> <p>Requires neither water supply nor refrigeration. Can be used at higher ambient without error by cooling sample to 220° F., or below before contacting bulb.</p>
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18 - MOISTURE CONTENT OF SOLIDS

Principle	Range	Accuracy*	Applications and Remarks
Resistance meters (Tigilabus, others). Resistance of massive solids is read between groups mounted a fixed distance apart, thrust into material. Resistance of powdered materials is read by applying standard component between plates, measuring resistance across plates. These are self-balancing bridge circuits and indicators.			Used for fiber content in paper, leather, tobacco and similar materials. Calibrated against materials of known moisture content.
Microwave-resistance meters (Bennet). Roll riding on wet paper or fabric passes current through to grounded roll. Measured as one leg of self-balancing bridge, calibrated as % moisture.			Used for sludge content in textile industry and in paper manufacture.
Dielectric-constant meter (Tagilabur). Since water has 15 to 20 times the dielectric constant of most materials, small changes in water content mean relatively large dielectric changes. Wettable material is put into test chamber; oscillation frequency of test cell circuit is set to standard frequency as produced in a second, crystal-controlled oscillating circuit.	Likely range of moisture content in commercial materials.	Hg.	Used chiefly on seeds, grains and powdered chemicals.
Dielectric constant moving-plate meter (Festron Co.). Box over moving web of moist material contains hygroscopic dielectric between condenser plates. Air in box and in dielectric airspace moisture equilibrium with moist material. Then equilibrium and hence moisture content of web determined as capacitance in high-frequency bridge.			Used extensively in paper mills to measure moisture content of paper as it progresses through paper machine.



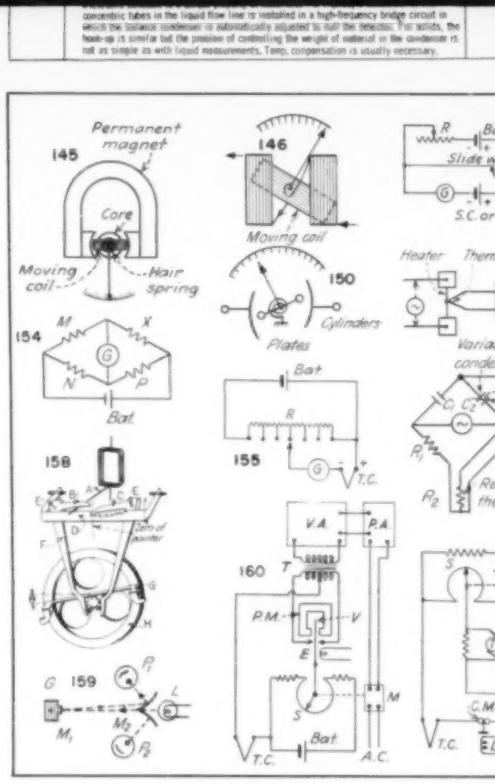
Figs. 123-132 - Instruments for measuring optical and chemical properties of materials.

19 - OPTICAL PROPERTIES (Color, Reflectance and Gloss, Smoke Density, etc.)

	Principle	Range	Accuracy*	Applications and Remarks
(1) Color	Fig. 127 - Color comparators. Used to obtain visual match of colors. First, standard is put at 5 and response of phototube P is obtained with white, red, green and blue light followed by filters at F (see figure 11). Then sample is put through same routine. Comparative response should give visual match.			Used on matching paints, dyes, paper colors and the like. Can also compare transmittance.
(2) Other	Photometric colorimeters. Most types, but in general they compare transmission of light from a sample with transmission from various length samples or standard. Light from an integrating sphere may be passed alternately through sample and standard, by use of a light chopper, comparative transmission being read with a photomultiplier tube. System can be calibrated to non-pulsating output of photomultiplier by reducing light reaching the standard. Some types use two similar phototubes, passing filtered light through sample to one cell, passing part of same light to reference tube. Tube outputs are then compared. Others use a single phototube and a rotating color wheel.			Used where exact transmission or reflectance of certain colors is needed for matching or record, but complete spectrophotometric curve is not needed.
(3) Optical Density	Reading spectrophotometers (General Electric Co.). Differs from filter photometers and comparators in principle in using a synchronous type monochromator in which monochromatic light of any desired wavelength from 400 to 700 millimicrons is produced by dispersion with prism and a slit. This light is passed alternately through a sample and a standard by a 90-cycle flicker motor to be reflected in an integrating sphere and a photomultiplier tube. The intensity of the light is measured by a vacuum fluorescent tube age from the phototube. Unique light produces an alternating current which is amplified to drive a balancing motor. Motor rotates a polarizing prism to alter light to standard for balance. Rotating chisel pin automatically follows continuously changing wave length to get % transmission or reflectance at each wave length.	Wave lengths from 400 to 700 millimicrons (1,000 is possible).	Results reproducible to 0.2%.	Used for color control for all types of colored products, enabling complete colorimetric analysis to be made and recorded. Operates automatically.
(4) Turbidity	Fig. 128 - Photoelectric (Gardner Luster) colorimeters, reflectometers, brightness, etc. Available in various types for aqueous systems at 20, 45, 60 and 90° angles. Type shown for beam striking surface at 15° from vertical, has one light source, two phototubes. One beam is referenced in concentrated on first phototube direct. Second beam is projected on surface to be measured, reflected one second phototube. Both outputs are compared by a null-balancing potentiometer which records % in reflectance. Standard cell permitted to differ up to 100%.		Precision 2 scale units.	Used in measuring reflectance of glossy products such as coated and supercalendared paper, enamels, paints, plastics.
(5) Density	Photoelectric turbidimeter (Exs Instrument Co.). Liquid containing undissolved substances or emulsions passes through cell. Beam of light passes through cell to phototube. Phototube output, measured by reading potentiometer, varies as light is more or less cut off by suspended particles.	Various ranges such as 0 to 15 or 0 to 100 ppm.	High. Function of range.	Used for monitoring turbidity, color or other light-absorption properties of process solutions.
	Color and density meter (Exs Instrument Co., others). Type shown uses alternating current (light) directed at sample in shade. Baileys Water Co. uses a thermistor (resistance thermometer) to measure reduction in heat received from a heated beam of light. Null-balance recorder is compensated for temperature.	Various. 0 to complete cut-off.		Used to monitor smoke stacks, measure density of water in paper mills. May be applied to electronic combustion control.

29 - COMPOSITION BY CHEMICAL PROPERTIES

Principle	Range	Accuracy*	Applications and Remarks
Fig. 126 - Olfat gas analyzers operate by absorption of components with subsequent measure of volume at standard pressure. Automatic type shows (Regentec Flow Meters Co.) measures CO_2 in gas flow. Proton P dissolves in sample at A , traps it at B , forces it into dilute KOH solution until neutralized at C , then escapes at H . O_2 method uses and scale gives percentage carbon dioxide in air.	0 to 20% CO_2 , any range possible.	High.	Used chiefly for measuring carbon dioxide in stack gases for combustion control.
Fig. 127 - Gas analysis by pressure drop. Gas passes through a restriction, an absorption chamber and another restriction in series. Differential pressure across the restriction is measure of % of gas absorbed.	0 to 50% approx.	Moderate.	Has been used chiefly for carbon dioxide.
Potentiometric titration. Neutralization and other end-points determined by suitable indicators and reference ion-selective electrodes. (Technicon Corporation, Englewood, N.J.)	Any.	0.5% or better.	Used in laboratory work but could be adapted to automatic analysis and control.
Fig. 128 - Sulphur detector for sulphur gases (Fritsch, Concentration G. Eng. Corp.). Automatic titrator for mustard, mustard sulphur gases. Gas enters titration cell C_1 , is titrated with bromine generated by current between electrodes H and B . Production of bromine controlled by sensing electrodes H and S_2 and suppressed reference voltage V_1 (cathode). Electrode E causes gas-sensing potential and output of L and M amplifiers R to increase because sulphur reacts with H_2S to release sulphur atom. Sulphur content measured in terms of electrodes H current by meter M .	Concentration as low as 0.1 ppm.	High.	Used to record low concentrations of sulphur-containing gases such as mustard, mercaptans, SO_2 , H_2S .
Fig. 129 - Sulphur detector by electrical conductivity (Thomas Autometer, L & R, N.Y.). SO_2 in air is absorbed in sulphuric acid and hydrogen peroxide H_2O_2 . Electrical conductivity is measured before and after absorption. Cell A by conductivity with cells C_1 and C_2 . Increase in conductivity is proportional to SO_2 concentration. Cell B is for H_2O_2 . Speed variation accumulated in cell A is proportional to SO_2 concentration. Cell B is for H_2O_2 concentration.	0 to 5 ppm SO_2 .	Accurate to better than 0.1 ppm.	Used in determining low concentrations of SO_2 in atmosphere.
Fig. 130 - Hydrogen sulphide by color change (Robins Co.). Phenacetin P_1 and P_2 continuously pass sensitized tape for darkening of lead acetate by H_2S . Cells are connected in bridge circuit O for continuous reading as H_2S .	Suitable for low concentrations.	High.	Same principle can be applied to other gases where suitable color change is available. Similar method used by G.E. for H_2S vapor.
Gas testers (Wiley Safety Appliances Co.). Special color change testers made for CO_2 , ammonia, chlorine, benzene, etc. Gas is passed over reagent which is regenerated on silica gel. Gas changes color with same scale for 5% detection limit.	CO from 10 to 1,000 ppm, H_2S from 25 to 400 ppm.	For trace element analysis as well as large concentrations.	Light-weight portable unit for manual use in detecting conditions within mining areas and process vessels.
Fig. 131 - Polarograph. Uses dropping mercury as a continuouslyimmovable electrode on which various ions plate out as potential increases. Required form step-like curve which indicates substances by position of spot, quantity by height.	Measures down to 10,000ths of 1%.	Primarily a laboratory instrument for quick, automatic analysis, especially trace elements in plating, organic chemicals, tube oil and explosives.	
Fig. 132 - Polarizing-cell oxygen analyzer (Wiley Safety Appliances Co.). Gas passes through a porous carbon tube which is the electrolyte in a cell containing a special electrolyte. A porous carbon tube is inserted between carbon electrodes. Oxygen passes through carbon impregnates cell. Current induced therefore depends on % oxygen. Recording potentiometer records 5% scale.	2% of scale.	General use for recording oxygen concentration.	



Figs. 145-163 - Instruments for electrical properties, an-

23. ELECTRICAL QUANTITIES

<p>Volts</p> <p>(i) Direct Current</p> <p>(ii) Alternating</p> <p>(iii) Current</p> <p>(iv) Power and Energy</p>	<p>General. This section deals mainly with those electrical instruments that are used as parts of, or in connection with, process instruments. It makes no attempt to cover electrical instruments exhaustively. In understanding the individual instruments, it should be noted that in most cases they actually measure current, regardless of the quantity in which the dial is calibrated. Most voltmeters are therefore similar to certain ammeters, except for having higher resistance and connected across a line, rather than in the line.</p> <p>Fig. 185 - Farnsworth-nagau, moving-coil voltmeter (analog). Series-disk D'Arsonval type, used for d.c. or a light load. Measures voltage or potential to be measured, within field of a magnet. Weighted linear reaction of field produced by coil with field of magnet causes rotation against a calibrated spring. Used for ranges from very low to very high. Galvanometers are instruments of this type.</p> <p>Fig. 186 - Electrodynammometer. Has two stationary coils and a moving coil, all in series. Reaction of the fields of stationary and moving coils on current flow causes rotation vs. a calibration.</p> <p>Fig. 189 - Rectifier bridge. Enables a d.c. voltmeter to be used for n.c. by connecting four diode rectifiers in a bridge so that, whenever one way the instantaneous current is flowing in the line, it always flows in the same direction through the meter. The arrangement is a so-called half-wave rectifier.</p> <p>Electrodynamic, galvanometer, (see Fig. 146) is more useful as an a.c. voltmeter than for d.c., since torque remains in same direction regardless of direction of current flow.</p> <p>Fig. 159 - Electrodynamometer. Drives almost no current. No connection is made to the opposite end of the moving coil.</p> <p>Current measurement. As noted above, current measurement devices are in general similar to voltmeters and so will not be detailed further, except for one unique type.</p> <p>Fig. 151 - Thermocouple ammeter. This device makes use of a heater through which the current passes, measurement, the other potential, and the combination watts.</p> <p>Power measurement, electrodynamic-type meters. Power in watts is commonly measured by an instrument similar to the electrodynammometer [Fig. 146] in which, the stationary field coils are in series with the load and the moving armature coil is shunted across the line. Hence, one measures current, the other potential, and the combination watts.</p> <p>Fig. 152 - Power by wattmeter converter. The heat and current can be measured for long distances. Power leads, connected across the line, are connected to the primary of a transformer. Loads from a current transformer are connected with a bridge circuit so that current in one side of the bridge is added to by current induced in the transformer, while current in the other side is opposed by transformer current. Hence the heat from resistors H_1 and H_2 will be different, depending on the load, and their average determined by the series thermometers, will be proportional to the load.</p> <p>Fig. 153 - Constant current the induction wattmeter method. Constant type of a.c. device</p>
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24 MEASURING METHODS

24. MEASURING METHODS

General. This section deals with the measuring devices that are used to convert the output of electrical industrial instruments into forms that can be used to operate a recorder, indicator or controller. It deals with measurements of potentials, resistances, capacitances or inductances. Such measurement methods are used with resistance thermometers, thermocouples, thermal conductivity cells, electrical conductivity cells, pH and redox cells, with strain gages and many position-measuring transmitting devices, and with a vast number of other types of instruments.

Most such electrical measurements are made by bridge circuits of one sort or another. These include the Wheatstone bridge, the Kelvin bridge, potentiometers, galvanometers and variometers. Some operate on d.c., some on a.c., and some may be used on either. Some, like the strain gage, measure the effect of a change in the physical condition of the strain gage. Some, like the example, measure the effect of a change in the temperature of the element of the strain gage.

Direct voltage measurement by millivoltmeter. To a considerable extent multiplying instruments are used for direct voltage measurement, as well as for the measurement of current and measurement of temperature by thermocouples. Many of these instruments are indicators, but recorders are also made, some in which millivoltmeter movement operates pen directly by a net of a cheaper bar and others through an integrator. In one recording mechanism follows millivoltmeter pointer without contact by means of an oscillating coil pickup system. In this method pointer carries slantwise base which moves between oscillator coil pickup system. In this method pointer carries slantwise base which moves between oscillator coil pickup system. If pen pointer attempts to move out of field of coils, output of an oscillating circuit is changed to drive a motor which causes coil pickup system to move in one direction and at same speed as pointer. Use of an oscilloscope is popular in corresponding position. Arm pointer can also operate control contacts easily, since plenty of power is available.

Fig. 155 - Voltage measurement by deflection potentiometer. In elementary potentiometer circuit of Fig. 147 it was noted that, with battery adjusted vs. standard cell, unknown voltages could be read by position of slider on slide wire which would give zero deflection of galvanometer. If slide wire is replaced by a series of tapped resistors, and galvanometer is calibrated as a millivoltmeter, then movable contact in unknown voltage circuit can be set at a point which will give the desired reading. The circuit of Fig. 155 illustrates this principle. The galvanometer is calibrated as a millivoltmeter as being measured. Then temperature is read as sum of that indicated by tap, and that read by millivoltmeter. Method is sometimes used where a low-cost indicator for one or a number of temperatures is desired and manual operation is suitable.

Voltage measurement by null-balance potentiometer. (See Fig. 8.) Most instruments requiring potential measurement use a null-type self-balancing circuit similar to Fig. 8. Null balance has advantage that, since no current is drawn in balanced condition, measurement is unaffected by leakage, shunt resistance, voltage collapse, or by changes in load. Long lead times are avoided. The circuit of Fig. 8 is a current reflector type, but a self-balancing potentiometer is provided for switching standard cell circuit for standardizing zener diodes by means of resistance R . Resistances 1, 2, and 3 are ordinarily of manganese for low temperature coefficient of resistance, and resistances 4, 5, and 6 are of manganin.

Fig. 157 - Weissenberg system (Weissenberg, Maxwell & Moore). This is an electronic-electromechanical system in which an electrical or mechanical input (measurement) is balanced against an accurately proportional d.c. output to an indicating or recording instrument. Basis of several variations of system is a balance beam which is heated by the primary measurement so as to affect an oscillating electronic circuit. Balance is restored to beam as circuit output reaches a value equivalent to initial upsetting force. Applied to measurement of a thermocouple potential, system consists of beam (Fig. 157) with calibrating spring, spring 5 and an annular at one end carrying cells C₁ to C₆. Beam is heated by a resistor R and is supported by a bearing on an electrically oscillating circuit. Voltage output of thermocouple TC applied to coil C₁ of beam so as to excite an electrically oscillating circuit. But this changes electric circuit output to recorder, also changing feedback through thermocouple TC to restore balance. Instead, C₁ and C₂ and electrical feedback may be omitted and direct mechanical feedback from recorder may be used to re-balance beam. Note that in this application system acts as a d.c. amplifier, because is comparable to a millivoltmeter in that circuit is not "nullied," and output resistance is to be compensated. Can operate up to 1,250 ft. from TC. On temperature, accuracy class 5% of range is claimed.

Fig. 158 - Mechanical-potentiometer (Lemly & Northrop). Simplified version of Wheatstone bridge, galvanometer-type 55-15 periodically disturbed by copper bar D. If D is not restored, this moves B to C or C to B. Cams not shown; restore C to horizontal, turn wheel H through angle theta. It operates slide wire and resistor pen. If balance has not been restored, next cycle continues its correction. Actual mechanism has vertical fingers which move in to sense pointer location when clamped, tilt H as shown, and not at H through gears. Same system used on bridge circuit. See Fig. 161 for electronic system used when higher degree of balancing is needed.

Fig. 159 - Electronic-potentiometer (Lemly & Northrop). This is a self-balancing potentiometer having a moving arm with slide-wire resistors. Sliding contacts, method of connecting, etc., are similar to null-balance potentiometer of Fig. 158. The main difference is that the electronic circuit has motor which turns



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May 1952

CHEMICAL ENGINEERING
Member ABC and ABP

Vol. 59—No. 5

Published monthly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Publication Office**, 99-129 North Broadway, Albany 1, N. Y. **Executive, Editorial and Advertising Offices:** McGraw-Hill Building, 330 West 42nd St., New York 36, N. Y. Curtis W. McGraw, President; Willard Chevalier, Executive Vice President; Joseph A. Gerard, Vice President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Senior Vice President, Publications Division; Ralph B. Smith, Editorial Director; Nelson Bond, Vice President and Director of Advertising; J. E. Blackburn, Jr., Vice President and Director of Circulation.

Subscriptions: Address correspondence to Chemical Engineering—Subscription Service, 99-129 North Broadway, Albany 1, N. Y. or 330 West 42nd St., New York 36, N. Y. Allow ten days for change of address.

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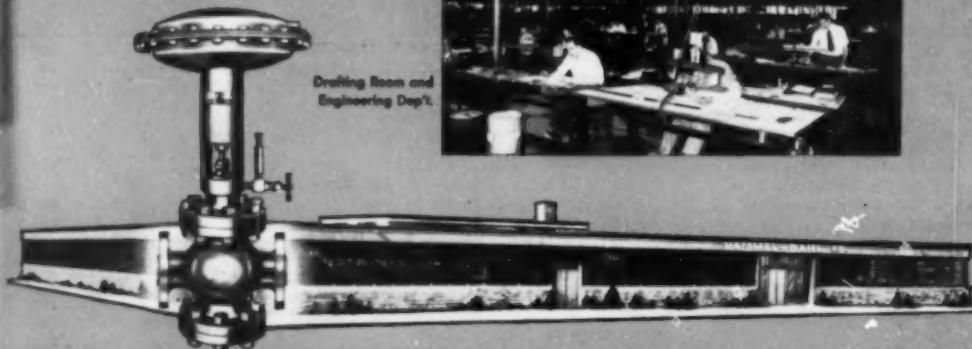
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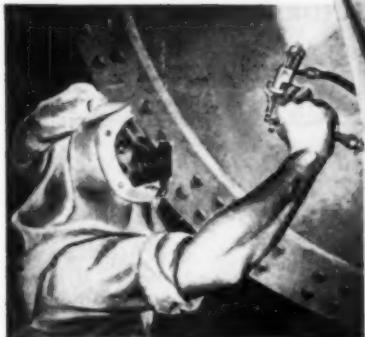
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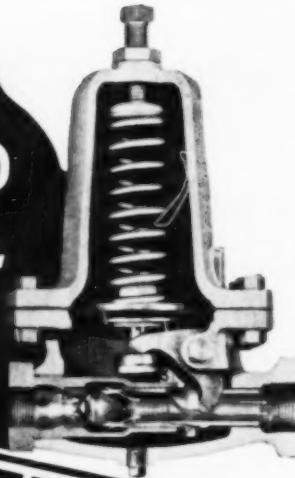
PROPERTIES AFTER 30-DAY IMMERSION

IMMERSION MEDIA	ROOM TEMPERATURE		60° C	
	Tensile (psi)	Elong.'n (%)	Tensile (psi)	Elong.'n (%)
Air Oven	—	—	9800	12
INORGANIC ACIDS				
Sulfuric Acid 20%	8500	12	10,000	12
Sulfuric Acid 80%	8900	12	9000	14
Hydrochloric Acid 30%	8600	10	9800	12
Nitric Acid 60%	8500	12	9000	12
Phosphoric Acid 75%	8600	10	10,100	11
ALKALI SOLUTIONS				
Sodium Hydroxide 10%	8600	11	9600	12
Sodium Hydroxide 50%	9100	11	10,000	11
SATURATED SALT SOLUTIONS				
Barium Sulfide	8400	11	9700	12
Calcium Hypochlorite	8400	11	9800	12
Tri Sodium Phosphate	8400	11	9700	12
Sodium Dichromate	8600	11	8600	12
ORGANIC ACIDS				
Acetic Acid 80%	8100	10	9500	12
Acetic Acid Glacial	7800	12	3000	10
. Sat.	8600	12	9800	12
. Sat.	8500	10	9800	11
Stearic Acid 100%	—	—	9500	11
ALCOHOLS				
Ethyl Alcohol	8400	11	6400	12
Butyl Alcohol	8700	11	8600	12
Amyl Alcohol	8600	11	9200	13
Ethylene Glycol	8700	11	9800	11
Glycerin	8700	10	9800	12
HYDROCARBONS				
Lubricating Oil ASTM #1	8400	10	9800	11
Lubricating Oil ASTM #2	8500	12	9800	13
Lubricating Oil ASTM #3	8600	12	9800	12
Gasoline 70 Octane	8400	11	—	—
Gasoline 100 Octane	8800	11	—	—
Hexane	8600	11	—	—
Kerosene	8700	11	—	—
Linsed Oil	8800	11	10,100	12
Castor Oil	8300	12	10,000	12
Cottonseed Oil	8500	12	9700	13
ORGANIC SOLVENTS				
Trichloro Ethylene	8800	11	10,000	11
Carbon Tetrachloride	8800	11	2100	190
Benzene	1700	140	Gelatinous	Gelatinous
Turpentine	8700	10	9200	11
Stoddards Solvent	9000	10	10,200	11
MISCELLANEOUS				
Hydrogen Peroxide 50%	9400	10	10,800	11
Formaldehyde	8300	10	9900	12
Triethanol Amine	5300	180	3000	130
Phenol	—	—	4800	120

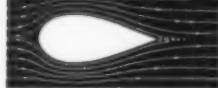
GEON RESINS • GOOD-RITE PLASTICIZERS...the ideal team to make products easier, better and more saleable.
GEON polystyrene materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

**PUT IT ON
THE LINE AND**

Forget it



CASH STANDARD
Streamlined TYPE 1000
PRESSURE REDUCING VALVE



**Streamlined
FOR SMOOTH EVEN FLOW
of Steam, Water, Air, Oil, Etc.**

wall AND the flow is not broken up by valve stems, springs, or other parts. Forget it once it's installed like others do. PROOF: "We have a large number of buildings scattered over about 100 acres of land. Just where we installed these Streamlined Valves I don't know. But I do know that I haven't seen or heard of them since they were installed."—Case No. 343. PROOF: "We installed four or five of your Streamlined Regulators. The last I heard of them they were holding pressure the same as when we first installed them. And as far as I know no one has ever touched them."—Case No. 345.

Bulletin 1000 will give you full details.

YOU GET MAXIMUM CAPACITY WHEN IT IS NEEDED MOST

TROUBLE-FREE SERVICE
SMOOTH OPERATION
TIGHT CLOSURE
NO SPOILAGE

CONSTANT DELIVERY PRESSURE
PRACTICALLY ZERO IN MAINTENANCE COST
SPEEDIER PRODUCTION RESULTS
COST-SAVING OPERATION

ACCURATE PRESSURE CONTROL AT ALL TIMES

CASH STANDARD

**CONTROLS..
VALVES**

**A. W. CASH COMPANY
DECATUR, ILLINOIS**

**BULLETINS
AVAILABLE
ON OTHER
CASH STANDARD
VALVES**

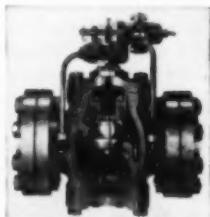
Send for them



Bulletin 948 features the CASH STANDARD Type 34 Pressure Reducing Valve—direct mounted—direct acting for handling steam, hot water, cold water, air, oil, brine—and most liquids and gases except some injurious chemicals. Illustrates and describes the different styles available and tells about their applications. Three pages of capacity charts.



Bulletin 956—features the CASH STANDARD Type 4030 Back Pressure Valve—designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.

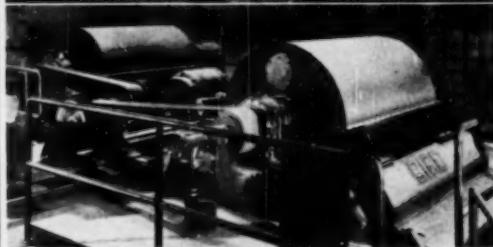
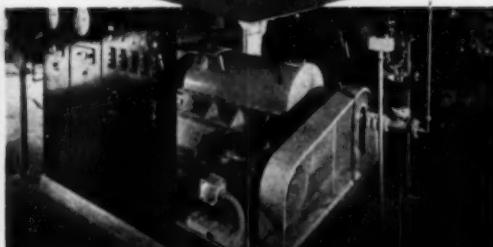


Bulletin 966—features the CASH STANDARD Self-Contained, Pilot Operated Type 10 Pressure Reducing and Regulating Valve for use with water or air, with any gas or oil that is non-corrosive, and with refrigerating fluids such as Ammonia and Freon. Many interesting particulars explained such as how valve works, tight seating, large capacity, no waste, no water hammer or chatter.

**GET
FILTRATION FACTS
HERE FIRST**



**THEN PUT
BIRD FILTERS
ON THE JOB**



No need to guess or gamble.

The Bird Research and Development Center has everything it takes to get reliable findings on *your* solids-liquids separation problems — get them on an adequate scale — and get them fast.

Hundreds of installations on everything from ores to oxides, pigments to potato starch, fish meal to foundry sand, testify to the success of this policy of *filtration facts first, then performance in the field.*

BIRD MACHINE COMPANY · South Walpole · Massachusetts

THE BIRD

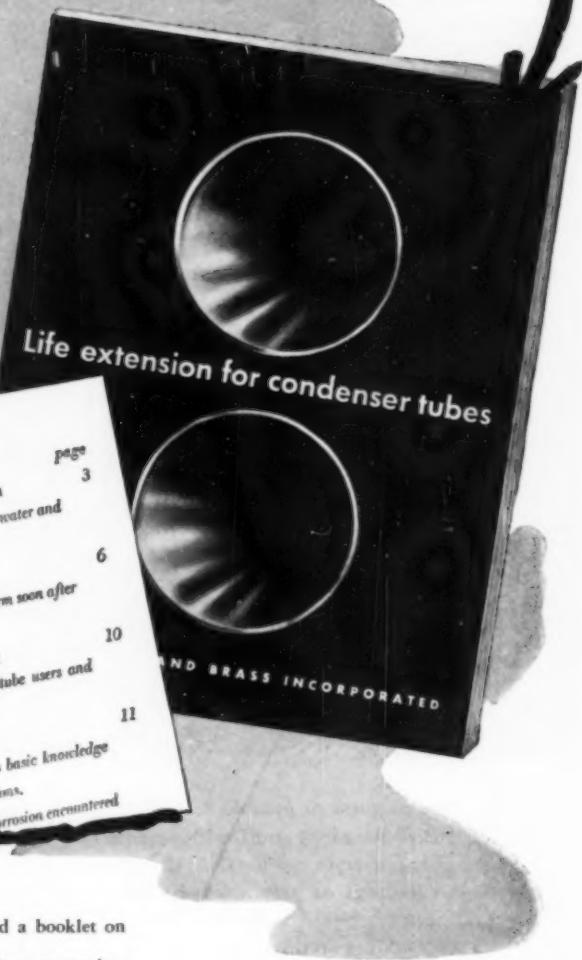
Continuous Centrifugal FILTER

"MUST" Reading

for Plant Engineers

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REVERE MINUTE MEN IN CONDENSER TUBE WAR "Trouble shooters" serve as liaison between tube users and Revere Research Laboratory.	10
DEVELOPMENT WORK IN TUBE ALLOYS Experiment in Revere laboratories develops basic knowledge of tube performance under variable conditions. <small>Various types of corrosion encountered</small>	11



• We doubt very much if you have ever read a booklet on Condenser Tubes, quite like this one.

Plant engineers should find it of unusual interest particularly with present restrictions on copper and its alloys making it more important than ever that every last ounce of use be squeezed out of the condenser tubes in their plants.

This 28-page booklet includes data on various copper alloys, photos of cut-away tube sections showing various types of corrosion encountered in condenser tube service and photomicrographs showing the grain structure of different kinds of metals under varying operating conditions.

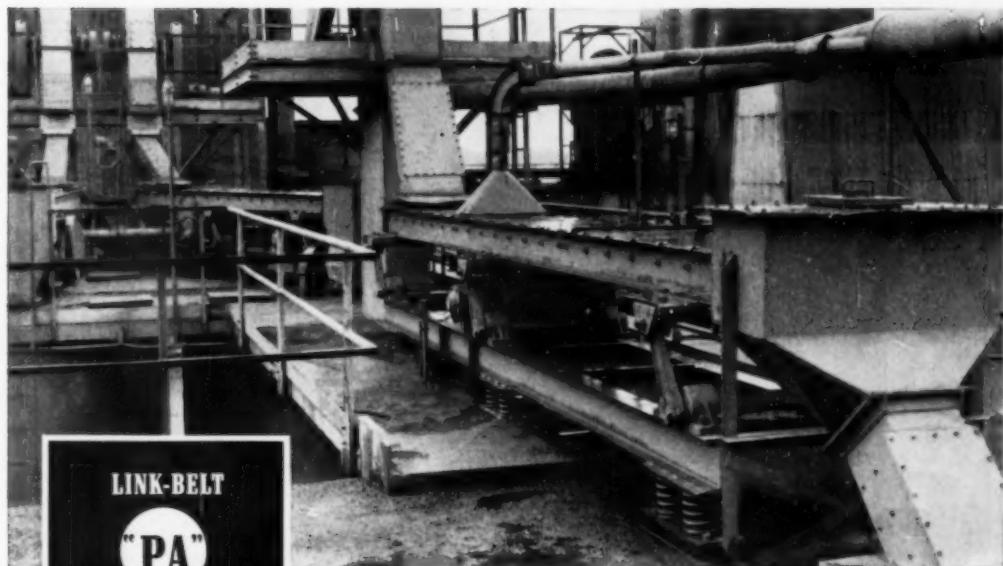
Send for your copy today. Please make request on your firm's letterhead. Thank you. Address Department P.R., Revere Copper and Brass Incorporated, 230 Park Avenue, N. Y. 17, N. Y.

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COPPER AND BRASS INCORPORATED

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230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere
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Yes, on every count
LINK-BELT "PA" OSCILLATING CONVEYOR
 opens new horizons in conveying



- (1) **"PA" POSITIVE ACTION**—uniform flow regardless of surges.
- (2) **LEAK-PROOF**—can be made dust- or gas-tight, eliminates spillage.
- (3) **SANITARY**—completely self-cleaning.
- (4) **COMPACT**—ideal for congested areas.
- (5) **LONG LIFE**—few moving parts.
- (6) **LOW MAINTENANCE**—only drive is lubricated, low operating frequency.
- (7) **GENTLE**—no breaking down of material.
- (8) **VERSATILE**—for a few pounds to 200 tons per hour.
- (9) **ECONOMICAL**—particularly on longer runs—spring action, minimum hp.
- (10) **BALANCED CONSTRUCTION**—can be furnished counter-balanced to isolate all vibration.

Three dust-tight Link Belt Oscillating Conveyors, 24 in. wide, handle 40 TPH of highly abrasive silicon carbide. Spring mountings isolate vibration.

► WHETHER you're handling steel turnings or salt . . . hot castings or cocoa beans . . . coal or flour — the ten engineering advances at left can mean stepped-up production at lower cost. Only Link-Belt's "PA" Oscillating Conveyor has them all!

This far-reaching development has many important advantages—high capacity, long life, heat resistance, enclosability. And the handling is so gentle, even a cigarette ash can ride the full run intact! Ask for Book 2444 for complete information.



"PA" OSCILLATING CONVEYORS

12,665

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices in Principal Cities.

Three "PA" models offer wide range of operating characteristics



"PA" FLEXMOUNT
for lighter duty, 8 to 24"
trough widths, up to 24 tons
per hr capacity.

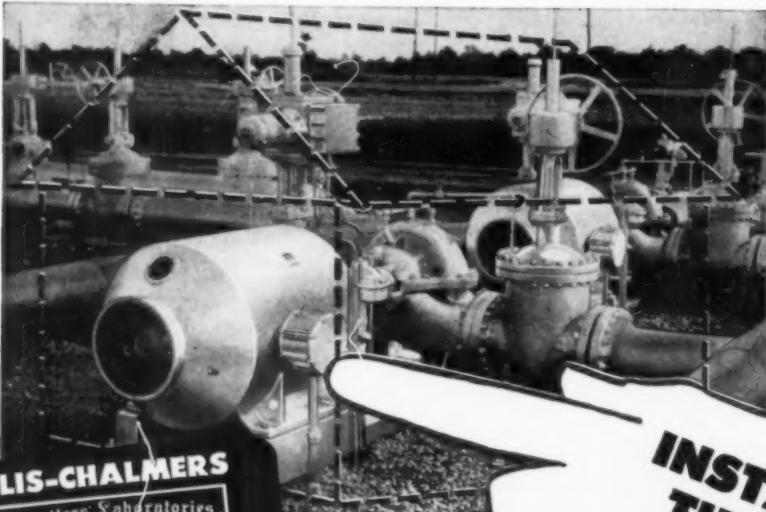


"PA" TORSION
MOUNT, pan trough,
for normal duty, 12 to
24 in. widths and up to 80
tph capacity.



"PA" TORSION
MOUNT, channel
trough for heavy-duty, 24
to 48 in. widths, capacities to
over 100 tph.

No building to buy!



ALLIS-CHALMERS
Underwriters Laboratories
INSPECTED
MOTOR FOR HAZARDOUS LOCATION
CLASS I GROUP D NO. 4
Tube-Type Motors

YOU CAN ELIMINATE costly building on many different kinds of installations by using Allis-Chalmers tube-type totally-enclosed, fan-cooled motors and installing them outdoors. The motors shown here operate outdoors all year round in a tough midwestern climate. Rain, snow, dirt, the weather's worst conditions, do not affect their dependable operation. And the same kind of savings can be made in hundreds of applications in many fields.

Self-Cleaning Feature Saves Maintenance

The cooling system in this unique motor is practically self-cleaning. Cool-

ing air is blown through straight, smooth tubes at sufficient velocity to clean out ordinary dirt. There are no corners or pockets to trap dirt or moisture. If sticky dirt clings, a ramrod will clean the tubes in seconds.

In either indoor or outdoor service, Allis-Chalmers tube-type, totally-enclosed, fan-cooled motors reduce maintenance by keeping themselves clean. *Also available in explosion-proof design.* Get full details from your A-C Authorized Distributor or District Office. Or write Allis-Chalmers, Milwaukee 1, Wis., asking for bulletin 51B7149. A-3699

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

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**INSTALL
THESE
MOTORS
OUTDOORS**

Sold . . .

Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers,
Certified Service Shops and Sales Offices
throughout the country.



CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.



TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

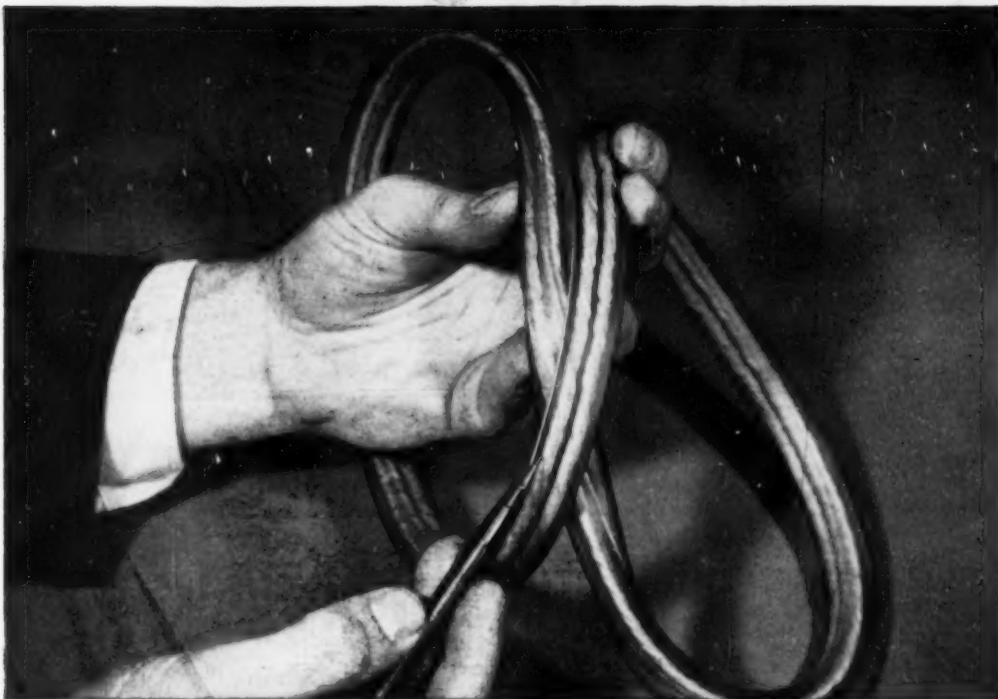


PUMPS — Integral motor and coupled types from ½ in. to 72 in. discharge end up.

RESEARCH KEEPS

B.F. Goodrich

FIRST IN RUBBER



Now you can see the difference between grommet belts and ordinary V belts

B. F. Goodrich grommet V belts last longer, serve better, save money

THE "X-ray" belt, made of transparent material, was developed just to show you the exclusive B. F. Goodrich grommet construction. Now you can look beneath the surface of a V belt, see for yourself what makes B. F. Goodrich grommet V belts last longer, keep running with fewer interruptions, need less attention.

Note the twin grommets—Each of these grommets is like a giant cable except that it's *endless*—a cord loop built up by winding heavy cord on itself. It has no overlapping ends. Because most of the failures in ordinary V belts occur in the region where cords overlap, the endless cord section

in a grommet V belt eliminates such failures.

Concentrated cord strength—All of the cord material in a B. F. Goodrich grommet multiple-V belt is concentrated in twin grommets, positioned close to the driving faces of the pulley. No layers of cords to rub against one another and generate heat; cord and adhesion failures are reduced.

Better grip, less slip—Grommet belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip pulleys better. Size for size, grommet belts give $\frac{1}{2}$ more gripping power, pull heavier loads with a higher safety factor. Be-

cause there is less slip, there is also less surface wear.

Only B. F. Goodrich has the grommet!—No other multiple-V belt is a grommet V belt (U. S. Patent No. 2,233,294). Now available in C, D and E sections. Your local BFG distributor has an "X-ray" demonstrator belt and will be glad to show it to you. *The B. F. Goodrich Company, Industrial & General Products Division, Akron, Ohio.*

Grommet V Belts *by*
B.F. Goodrich
RUBBER FOR INDUSTRY

NOW AVAILABLE...



from CARBIDE AND CARBON'S expanded production facilities

Ethanalamines are available now in greatly increased quantities—a result of added facilities for production of Ethylene Oxide.

Mono-, di-, and triethanolamines have been produced by CARBIDE and CARBON since the 1930's. CARBIDE's long experience in production of these basic materials assures you of high, uniform quality.

Use ethanolamines for acid gas absorption, for solubilizing 2,4-D, and for making synthetic detergents, soluble metal-cutting oils, corrosion inhibitors, and other amine derivatives.

Drum stocks of ethanolamines can be delivered promptly from warehouses in principal industrial areas. Compartment and full tank car lots can be shipped promptly to meet your needs.

For complete information, phone or write our nearest office.

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CHEMICALS COMPANY
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Union Carbide and Carbon Corporation
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Offices in Principal Cities
in Canada: Carbide and Carbon Chemicals, Limited, Toronto



Carries the Load for WYANDOT DOLOMITE

Fairfield Conveyor Systems work around the clock for Wyandot Dolomite, Inc., Carey, Ohio, in handling and processing dolomite.

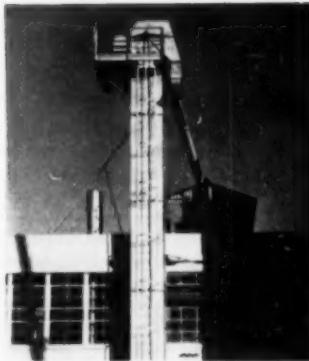
A typical example of the many rugged material handling jobs assigned to Fairfield, these systems utilize every component in the bulk material handling field to bring you economical operating costs by eliminating costly old-fashioned material handling methods. Then too, responsibility for the complete handling system rests with one source—for Fairfield designs, fabricates and installs the complete job.

Check with this outstanding organization on your bulk material handling needs today. Bulletin 152, describing Fairfield Systems, is available on request. Write the Contract Division, Fairfield Engineering Company, Marion, Ohio.

THE FAIRFIELD ENGINEERING COMPANY
349 Chicago Ave., Marion, Ohio



Specialists in bulk material handling

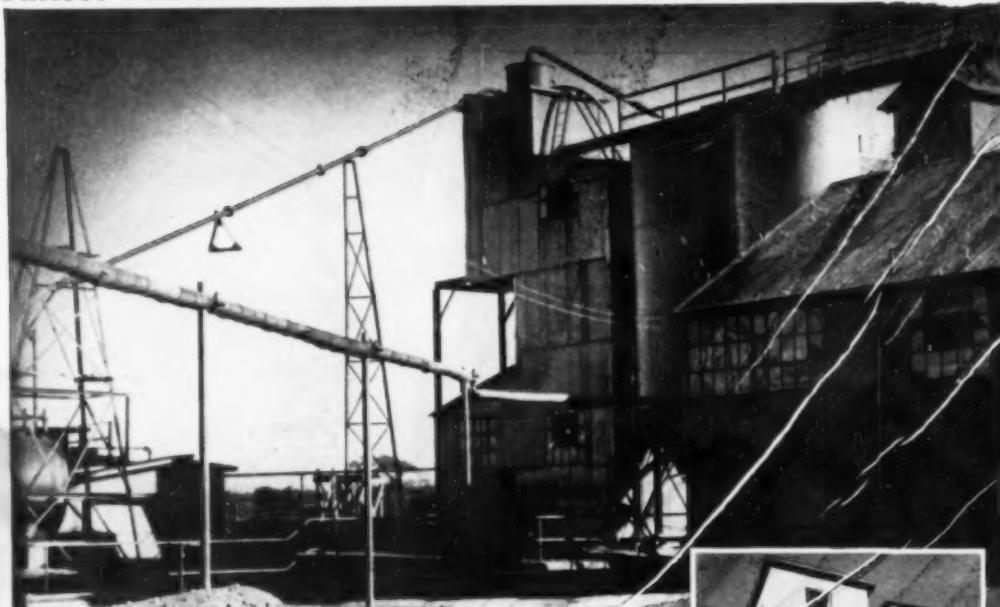


Centrifugal discharge type elevator designed and built by Fairfield at a modern processing plant.



One of a great variety of Fairfield Belt Conveyors at work in an eastern chemical plant.

DRACCO PERFORMANCE-PROVED EQUIPMENT



TOXIC CONDITIONS ELIMINATED ...at a Profit!

A Dracco Pneumatic Conveyor is the obvious answer for handling your toxic or hazardous bulk materials safely and swiftly—with savings!

This modern technique is being used by an eastern manufacturer of insecticides for handling lime, lead oxide, and crude arsenic. The Dracco system replaced slow wasteful manual methods which exposed workmen to burns, poisoning and injury. These conditions were eliminated by the Dracco Pneumatic Conveyor, which has more than paid for itself in labor and cost savings.

Designed for flexible operation, the pneumatic conveyor was Dracco-engineered to the exact job requirements of this plant. The dual-unit system unloads railroad cars and transfers materials from primary processing or storage to final processing at five tons per hour.

This is only one of many installations where automatic, high-efficiency Dracco Pneumatic Conveyors are solving difficult materials handling problems. Dracco engineers are at your service to apply these modern, cost-saving methods to your specific problem.

DRACCO CORPORATION

Harvard Avenue and East 116th Street • Cleveland 5, Ohio

Consult your nearest Dracco representative
or write Dept. C-5, Cleveland 5, Ohio, for
specific information on Dracco Equipment.



(Upper photo)—Aerial conveying line (top left) moves materials from primary processing to storage or final processing in a Dracco Pneumatic Conveyor system at eastern insecticide plant.

(Lower photo)—Reclaim lines transfer materials from storage to final processing. Versatile system also unloads railroad cars, moving materials to storage or processing.

DRACCO

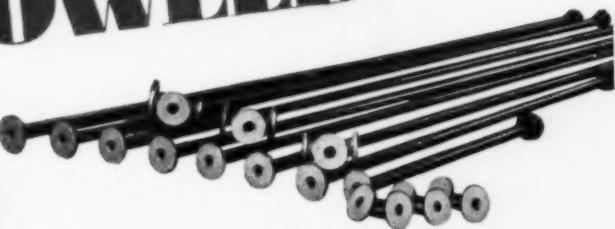
Performance Proved

DUST CONTROL EQUIPMENT • PNEUMATIC CONVEYORS

You Can Save More with

PLIOWELD

Lined Piping



WHEREVER you handle corrosives, abrasive materials and other enemies of metal piping, it will pay you to investigate the savings you can make with PLIOWELD—Goodyear's lining material that bonds *permanently* to metal surfaces.

7 REASONS WHY

THE G.T.M. SPECIFIES PLIOWELD

- 1 Effectively seals in corrosives that cannot be handled in metal
- 2 Bonds permanently to metal surfaces—an exclusive Goodyear process
- 3 Does not split or loosen with vibration or severe external impacts
- 4 Does not crack or buckle under alternate wetting and drying or under temperature changes
- 5 Surface will not disintegrate or slough off—cannot ever contaminate in-process materials
- 6 Protects product from discoloration, iron "pickup" and other contaminants
- 7 Each installation specially formulated to provide maximum protection against chemical handled

The G.T.M.—Goodyear Technical Man—will gladly discuss your problem—and recommend a PLIOWELD lining matched to your needs that will give you these benefits:

LOWER OVER-ALL COST because the useful life of PLIOWELD lined pipe so far exceeds unlined pipe that its slightly higher initial cost is more than made up by your savings in replacement outlays.

LOWER MAINTENANCE COST. Because PLIOWELD is absolutely impervious to corrosion, daily inspections and frequent maintenance shutdowns are eliminated. *The savings this means should cover the cost of PLIOWELD lining in a short time.*

IMPROVED PRODUCTION where PLIOWELD lined pipes handle production items. Your product is protected against taint and discoloration because the lining won't slough off or contaminate liquids.

Ask the G.T.M. about PLIOWELD lined pipes, fittings and equipment—everything from laboratory equipment to rail tank cars—or write Goodyear, Akron 16, Ohio.

Ploweld-T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

GOOD YEAR

THE GREATEST NAME IN RUBBER

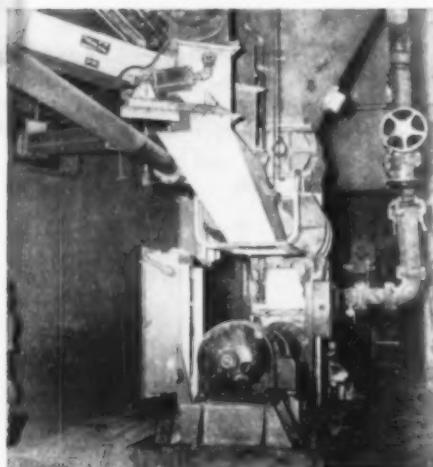
SOLVED

**Gouverneur Talc's
MATERIAL HANDLING PROBLEMS
with Fuller Conveying Systems**

- A. FULLER ROTARY AIR COMPRESSORS.
- B. F-H PUMP HANDLING PRODUCT OF FLUID ENERGY MILLS.
- C. F-H PUMP HANDLING PRODUCT OF HARDIGE MILL.
- D. F-H PUMP HANDLING PRODUCT OF DUST COLLECTOR.
- E. F-H PORTABLE PUMP HANDLING ALL PRODUCTS TO PACKER BINS OR BULK LOADERS.
- F-H OPEN AND CLOSED TYPE AIRSLIDES CONVEYING FROM FLAT-BOTTOM STEEL BIN TO PORTABLE F-H PUMP.
- G. BLOWER SUPPLYING AIR TO ALL AIRSLIDES.
- H. ALLEVATOR FEEDING PACKER BIN.



Lading bulk talc in box car



Fuller-Kinyon Portable Pump underneath silos. Airslide (upper left) from flat-bottom bin, for delivery to pump.

Gouverneur Talc Company, (subsidiary of R. T. Vanderbilt Company of New York) has solved its conveying problems with a Fuller-Kinyon Conveying System and F-H Airslides. Three Fuller-Kinyon Stationary Pumps convey materials from pulverizers and dust collector to the storage silos and flat-bottom storage bins. One additional Fuller-Kinyon Portable Pump delivers "Nytal" talc from the silos and bins to the bulk-loading station and packer bin. Airslides, equipped with air-motor-operated cut-off gates, actuated by bin-level indicators in the packing bin, empty the flat-bottom bins directly into the portable-pump hopper.

Fuller equipment has solved Gouverneur's material handling problems conveniently and economically, reducing costs and increasing handling efficiency. It can do the same for your plant.

Ask for a free Fuller survey to determine the most economical and efficient method for handling your materials.

**DRY MATERIAL CONVEYING SYSTEMS
AND COOLERS—COMPRESSORS AND
VACUUM PUMPS—FEEDERS
AND ASSOCIATED EQUIPMENT**

Fuller

FULLER COMPANY
Catasauqua, Pa.

120 So. LaSalle St., Chicago 3
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G-72

May 1952—CHEMICAL ENGINEERING



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it's **TEAM-WORK**
that counts

Although the stars on the Chemical Plant's team are not publicized, the roster is made up of engineers and other specialists having outstanding performance records. Chemical Plants Division is staffed to "take over" tentative plans and see the job through to completion with competence, speed and economy. Whether the project calls for a packaged gasoline plant, an addition to your present facilities or the construction of a complete process plant ready for operation, Chemical Plants is interested in playing ball with you.

CHEMICAL PLANTS DIVISION

BLAW-KNOX CONSTRUCTION COMPANY

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If you will put a Jenkins Valve, recommended for your particular service, on the worst place you can find — where you cannot keep other valves tight — and if it is not perfectly tight or it does not hold steam, oil, acids, water or other fluids longer than any other valve, you may return it and your money will be refunded.

Jenkins Bros.

A FAIR OFFER THAT HAS BEEN IN EFFECT
SINCE 1869

JENKINS
LOOK FOR THE DIAMOND MARK
VALVES



This famous "Fair Offer" has been published at frequent intervals for the past 83 years. It can be repeated, again and again, only because all Jenkins Valves measure up to its sincere pledge of exceptional dependability.

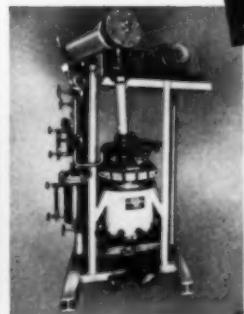
Despite their *extra value*, proved by countless economy records in every type of service, *you pay no more* for Jenkins Valves. Jenkins Bros., 100 Park Ave., New York 17.

Standard or Special
Large or Small...

BLAW-KNOX
BUILDS THEM ALL!



Special Vertical Autoclave
for curing safety glass.



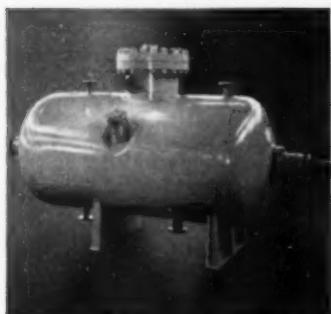
Electro-Vapor® Heated
Resin Pilot Plant



Flush Type Plug Valve



Stainless steel Granulation
Blender



Horizontal Jacketed Autoclave
with helical type agitation.



Jacketed Rotary Carbonator



Cut-away view of Electro-Vapor®
heated Reaction Kettle.

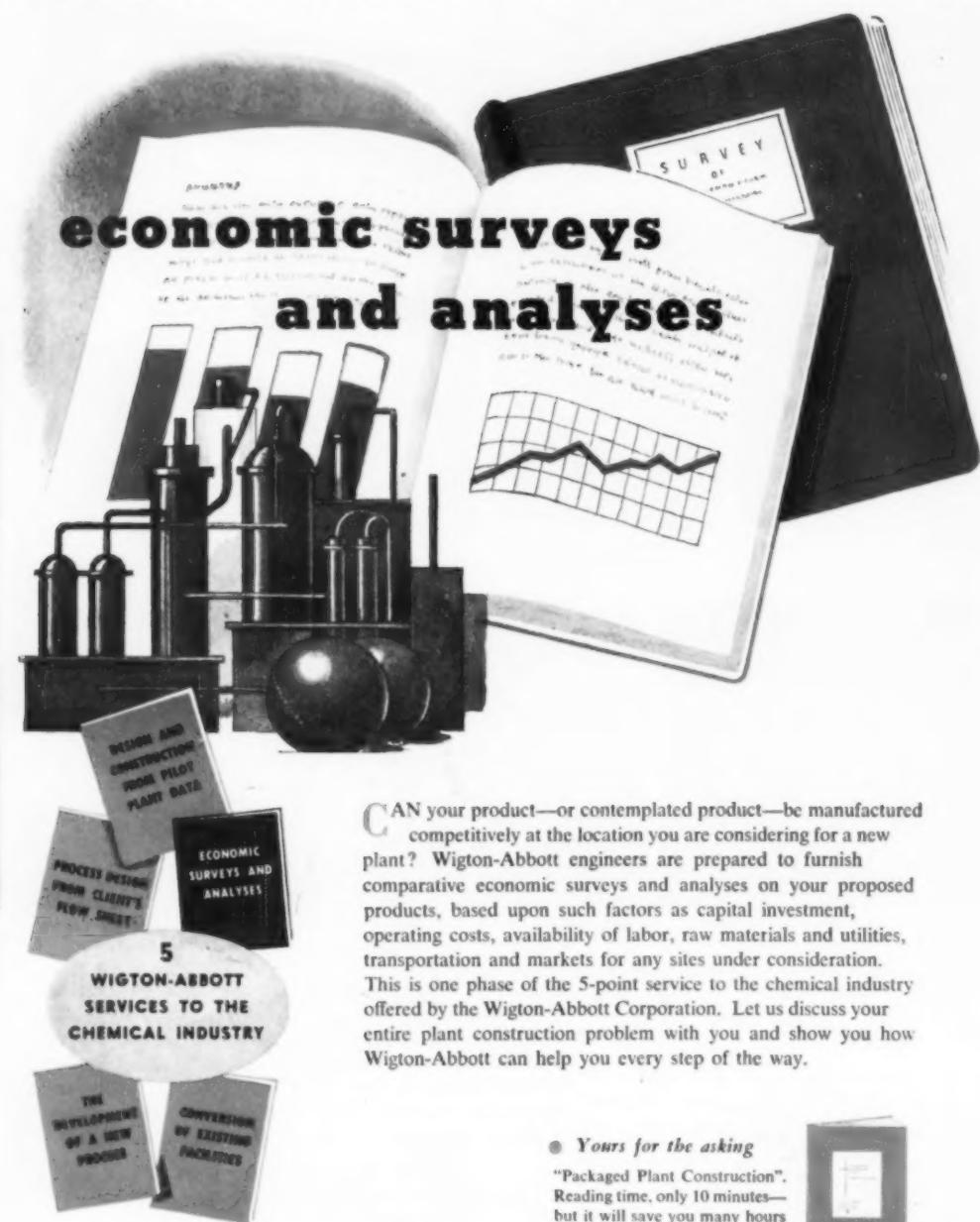
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Do you need a $\frac{1}{2}$ -gallon laboratory autoclave? Or a commercial unit of several hundred gallons capacity? Blaw-Knox has the extensive manufacturing facilities and engineering experience to furnish processing equipment which will meet your requirements in every respect. In addition to standard units we also fabricate special equipment to specifications. For further information write for Bulletin 2383.

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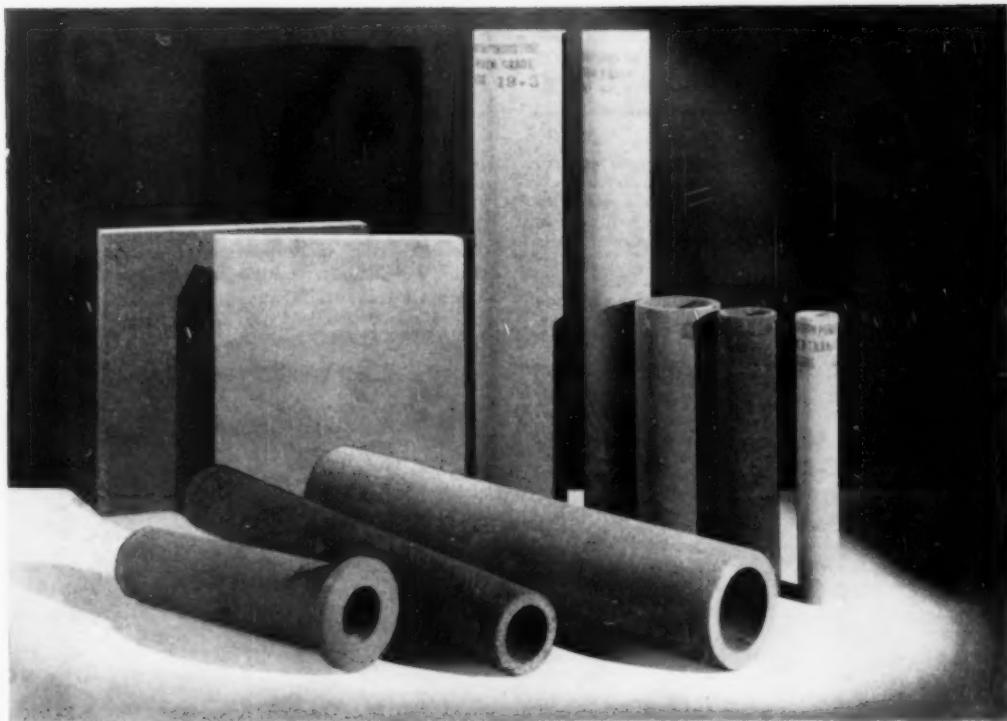
● *Yours for the asking*

"Packaged Plant Construction". Reading time, only 10 minutes—but it will save you many hours by answering basic questions.



Wigton-Abbott Corporation

DESIGNERS...ENGINEERS...CONTRACTORS...PLAINFIELD, NEW JERSEY



For greater filtration efficiency,
easier cleaning operation . . .

Norton ALUNDUM* Seamless Tubes

Increase the efficiency of your filtration system with Norton porous seamless tubes. Made of long lasting ALUNDUM grain, their seamless construction assures more uniform filtration and faster, more thorough cleaning by back-washing.

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Norton porous mediums, in both tube and plate forms, bring you chemical stability unaffected by most corrosive acids, strength that assures maximum resistance to breakage and chipping . . . controlled structure (an exclusive Norton process) that permits positive

control over grain spacing and pre-determined pore size and open pore ratio to meet your requirements.

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Plan now to get complete data on these Norton refractory products by obtaining Norton Bulletin No. 140:

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NORTON

POROUS MEDIUMS

Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

For centralized control with greater flexibility

Here's an attractive, versatile new motor control center that you can easily plan, install, and service. Compact—a section is only 20 inches wide, 20 inches deep, and 90 inches high. It will accommodate NEMA Size 1 through 4 starter units back to back.

A four-inch wiring trough provides ample space for outgoing wires and cables. Starter units are designed for easy inspection and servicing.

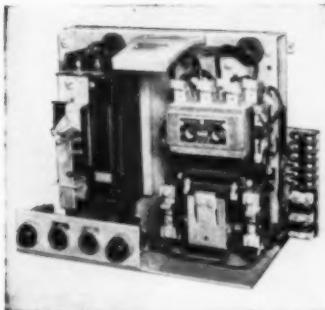
Announcing

There are many provisions for protecting personnel from mechanical and electrical injury. This G-E motor control center has also been laboratory tested to assure protection against 25,000 amperes short-circuit current. More information on this new, modern motor control center in bulletin GEA-4979A. Write your nearest G-E office today. *General Electric Co., Schenectady, N. Y.*

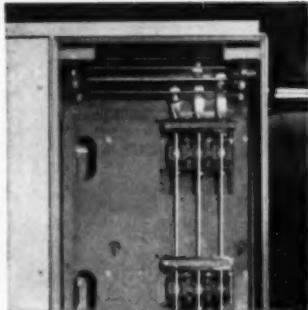


THIS COMPACT, ATTRACTIVE, G-E MOTOR CONTROL CENTER provides the most modern method of controlling a-c motors up to 200 horsepower from a central location.

the NEW General Electric Motor Control Center



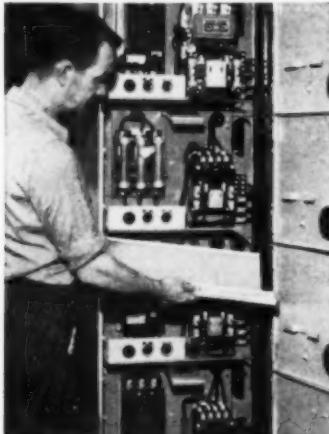
STARTER UNITS ARE COMPLETELY ACCESSIBLE. All components—even the pilot devices—are mounted on a sturdy frame with all terminals front connected.



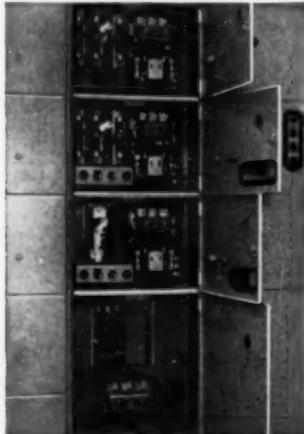
DESIGNED TO PROTECT PERSONNEL. Rear view shows metal barrier that separates starter unit space from bus bars. Vertical section features new "I-beam" construction for strength.



EASY TO INSTALL AND INSPECT. Sturdy, light-weight starter units are easy to handle, and interchangeable because of standardized dimensions and components.



EASY TO WIRE. Ample four-inch wiring trough is completely accessible by removing horizontal metal barriers between units. Barriers isolate and support units as they are slid into section.



VERSATILE. Starter unit sizes and types are in even multiples of 14 inches. Fusible and circuit breaker combinations of the same starter size are interchangeable without changing doors.



EASY TO SERVICE. Doors swing wide (no hinge wiring); unit is easily disconnected from bus and held in test position for protected servicing.

GENERAL  **ELECTRIC**

710-31



RECESSED-END FITTINGS . . . Stainless Type 304-347-316. Low cost, light weight fittings for fast, simple soldering, brazing or socket welding. Sizes from $\frac{1}{2}$ in. thru 24 in. Full line of elbows, tees, adapters, etc. Covered in Catalog 948.



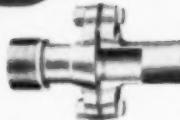
"ZEPHYRWELD"® WELDING FITTINGS . . . SS Type 304-347-316—Inconel and other SS analyses. Fabricated in O.D. Pipe and Tube Size, $\frac{1}{2}$ in. thru 24 in.—elbs., tees, adapters, etc. Covered in Catalog 748.



CLAMP-TYPE CONICAL FITTINGS . . . requires only 1 simple ferrule; assures leak-tight joints thru sanitary Teflon gaskets. Fast, simple assembly and disassembly. Full line in sizes from 1 in. thru 4 in.



SANITARY TYPE FITTINGS . . . Stainless Steel and Tri-Alloy (Nickel Alloy), from 1 in. thru 4 in. O.D., full range of fitting types. Approved as meeting 3A Standards throughout, incorporating exclusive design features. Covered in Catalog 150-B.



CONICAL END FITTINGS . . . Stainless Type 316—Inconel and other SS analyses. Complete line, sizes from 1 in. thru 4 in. O.D. Features: Light weight—low cost—fast installation—leak tight—easily adapted to other fitting types. Covered in Catalog 848.

Try TRI-CLOVER

. . . for the COMPLETE LINE* of
LOW-COST CORROSION-RESISTANT PIPING
. . . in both **Tube O.D.** and **Pipe O.D.** types

Here you see five representative fitting types that go to make up the complete Tri-Clover line—all available from one source. Install these stainless steel or alloy products in your process lines and realize the advantages of increased production and lower maintenance cost. 32 years of specialized experience in solving corrosion piping problems can be yours by consulting our engineers.

Write for details, or see your nearest Jobber.

*ALL FROM 1 SOURCE

The **COMPLETE Tri-Clover Line** includes:

- Flared Tube Fittings (Kensettik)
- Tube O.D. Butt-weld Fittings (Zephyrweld)
- I.P.S. O.D. Sch. 5 and 10 Butt-weld Fittings (Zephyrweld)
- I.P.S. O.D. Sch. 40 and 80 Butt-weld Fittings
- Flanged Conical End Fittings (Tube O.D.)— $1\frac{1}{2}$ " Through 4"
- Industrial Recessed End Fittings (Tube O.D.)— $1\frac{1}{2}$ " Through 10"
- Screwed and Flanged Valves (Powell)
- Special Fabricating Facilities
- 3A Standard Sanitary Fittings and Valves (Stainless Steel and Tri-Alloy)
- All-Sanitary Magnetic Full-Flow Traps
- Centrifugal Pumps—Sanitary and Industrial
- Stainless Steel Tubing and Pipe—All Sizes and Analyses

(Inventories carried in distributors' stocks strategically located throughout the United States.)



TRI-ALLOY AND STAINLESS STEEL
SANITARY FITTINGS, VALVES,
PUMPS, TUBING, SPECIALTIES

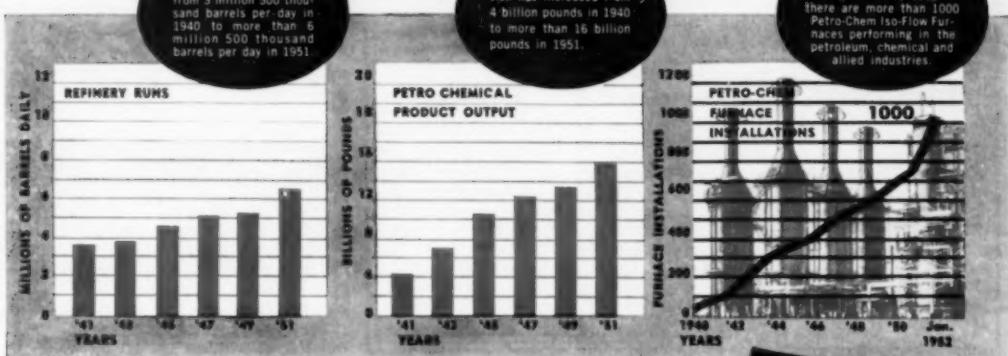
THE Complete Line

FABRICATED STAINLESS STEEL
INDUSTRIAL FITTINGS AND
INDUSTRIAL PUMPS

CONFIDENCE spells growth

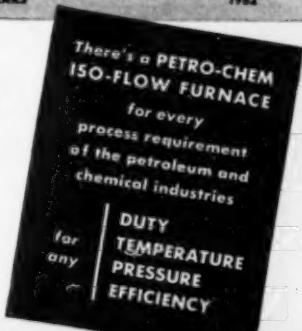


There's many a reason for the parallel growth of the Petro Chemical Industry and the increasing use of Petro-Chem Iso-Flow Furnaces by leading Petro Chemical Companies.



ISO-FLOW FURNACE USERS KNOW . . . that the Petro-Chem Development Company has but one basic product; processing furnaces for petroleum, chemical and allied industries. As a result of experience, they know that it does not pay to build their own furnaces; that Petro-Chem Iso-Flow Furnaces cost less, operate efficiently and usually beyond their rated capacity . . . they know that all process data made available for the design and engineering of Petro-Chem Iso-Flow Furnaces is kept strictly confidential . . . never released by Petro-Chem Development Company engineers.

The Petro Chemical, Petroleum, Chemical and allied industries can be confident that as they grow in size and advance in technology, so Petro-Chem Iso-Flow Furnaces will keep pace.



PETRO-CHEM ISO-FLOW FURNACES
UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INCORPORATED
227 EAST 47TH STREET, NEW YORK 17, N. Y.

Bethlehem Supply, Tulsa and Houston • Flagg, Brackett & Durgin, Boston • D. D. Foster, Pittsburgh
Faville-Levally, Chicago • Lester Oberholz, California • Gordon D. Hardin, Louisville, Kentucky

HERE'S HELP... to make

PULP & PAPER

PAPER (Converting)

PACKAGING



Beater Sizing

S/V Ceremuls—Improve finish, reduce curl.

Pitch Control

S/V Sovalent 911—Attacks pitch in sulphite digester, increases pulp production.

Surface Sizing

S/V Ceremuls—Add water resistance, improve finish.

Water Absorbency

S/V Sovatek A—Softens... improves re-wetting.

Pitch Removal

S/V Sovaloxes—Remove pitch from wires, screens and felts.

Defoaming

S/V Foamerxes—Reduce foam in chests, on wires, and in effluent waste streams.

PRINTING



Electrotyping

S/V Cerese Wax—For clear halftones and fine stipple.

High-Grade Inks

S/V Cerese Wax—Improve toughness, prevent "skinning."

Ink Lengtheners

Special Compounds—Give good pigment dispersion.

Carbon Papers

S/V Microcrystalline Waxes—Improve "pick-off," extend paper life.



Laminating

S/V Microcrystalline Waxes—Set new laminating strength standards.

Wax Coating

S/V Microcrystalline Waxes—Impart low temperature flexibility to paraffin waxes.

Wax Impregnation

S/V Microcrystalline Waxes—Enhance grease, oil resistance.

Oil Impregnation

S/V Prorex Oils—Produce odorless food wraps.

Vinyl Coating

S/V Ceremuls—Added to lattices, prevent blocking.

Grade C Wrap

S/V Microcrystalline Waxes—For coating and laminating.

GLASS



Glass Etching

S/V Microcrystalline Waxes—Etch resist... eliminate "fuming"; give sharp needle etch.

Glass Molds

Special Oils—Easily applied, reduce die wear and rejects.

Rust Prevention

S/V Sova-Kotes—Protect glass molds during storage.



Frozen Foods

S/V Magnowax—Sets new standards for toughness and flexibility.

Paper Milk Containers

S/V Sovawax D—Provides strong ductile paraffin wax coating.

Container Linings

S/V Microcrystalline Waxes—For barrels, drums and cans.

Rust-Proofing

S/V Sova-Kotes—Keep metals from rusting.

Service Forces' Requirements

S/V Microcrystalline Waxes—For dip-coating and sealing.

RESINS, PLASTICS



Vinyl Compounds

S/V Sovaloid C—Total or partial plasticizer for low-cost compounds; completely compatible, will not migrate.

Vinyl Plastisols

S/V Sovaloid C—Produces free-flowing compositions.

Natural Resins

S/V Sovaloid N—Low-cost plasticizer, completely compatible.

Check this list for ways to Speed Operations—Lower Costs

- The chances are that the product you have been looking for—to meet one of your processing needs—is listed right here on these pages.

Your Socony-Vacuum Representative will be glad to give you details—and help you apply this product to your particular requirements.

SOCONY-VACUUM

Process Products

CERAMICS



Dry-Pressing

S/V Ceremuls—Binders, improve flow properties, increase density.

Steatite

S/V Ceremuls C—Increases green strength, maintains electrical properties.

Grinding Wheels

S/V Ceremuls R—High strength binder for dense abrasives.

Brick, Pottery

Special Oils—Retard die wear and reduce rejects.

FOOD, DRUGS



Streptomycin; Penicillin

Special Defoamers—Prevent foam, assist sterilization.

Meat Processing

S/V Prorex Oil M—Coats chutes, hooks, knives and tables to prevent rust.

Beet Sugar

S/V Foamrex S—Reduces foam, speeds processing.

Eggs In Storage

S/V Prorex Oil C—Protects eggs in cold storage.

Yeast

S/V Foamrex—Retard foam, eliminate production difficulties.

CHEMICALS

Benzonitrile

An intermediate used in the manufacture of resins and dyestuffs.

Thiophene

Used in anti-histamines; of interest for dyestuffs, insecticides and textile chemicals.

your product better!

It may be, however, that you have a highly specialized problem, one that requires a product not yet in existence. If so, your Socony-Vacuum Representative is ready to study your need...and seek the answer from petroleum.

At any rate, you can't afford to overlook the tremendous possibilities in this field...to improve your processing operations...and lower your costs. Now's the time to get the facts.



SOCONY-VACUUM OIL CO., INC.
26 BROADWAY,
NEW YORK 4, N. Y.
and Affiliates:
MAGNOLIA PETROLEUM CO.,
GENERAL PETROLEUM CORP.

BUILDINGS



Concrete Blocks
S/V Form Fluid B—Prevents sticking and staining during manufacture.

Ice, Snow Control
S/V Heat Transfer Oil Light—Acts as non-corrosive heat transfer medium.

Insulation
Special Products—Produce fluffy waterproof rock wool.

GENERAL



Paint, Varnish
Sovasols and Sovalents—High-quality vehicles for coatings.

Air-Conditioning
S/V Sovabead—Dries air, increases personal comfort.

Sewerage Plants
S/V Foamrex X—Controls foam in sewage disposal plants.

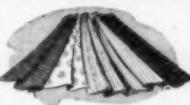
Heating
S/V Heat Transfer Oil—Resists sludging.

Refrigeration
S/V Sovabead—Keeps Freon and other refrigerants dry.

ELECTRONICS

Radio Parts
S/V Cerese Wax—Maintains electrical properties of coils and condensers.

TEXTILES



Woolens

S/V Woolrex Oils—Excellent scourability—oxidation resistance.

Worsted

S/V Sovatex Oils—High-quality oils for Bradford and French systems.

Cottons

S/V Weavrex 200—Light-stable plasticizer for warp-size compositions.

Rayons

S/V Sovatex Oils—Oxidation-resistant fiber lubricants.

Water Repellents

S/V Fabrisoles—Versatile...for light and heavy fabrics...military ducks, twills and webbing.

Paper Twine & Yarns

S/V Ceremuls—Improve twisting properties, impart water resistance.

CORDAGE



Jute, Sisal

S/V Batching Oils and Wax Emulsions—Improve fiber processing.

Water-Repellency

Special Wax Compounds—Give water resistance, prolong life.

Wire Rope Cores

S/V Rope Saturant G—Used as impregnant in cores; gives internal protection.

Oil Well Cable

S/V Cordage Compound 269—Oxidation-resistant internal lubricant.

RUBBER



Buna N Plasticizer

S/V Sovaloid C—Completely compatible. Does not bloom.

Neoprene

S/V Sovaloid L—Imparts low temperature flexibility. Sovaloid N produces low hardness compounds.

Sun-Check Wax

S/V Wax Compounds—Retard surface cracking or checking.

Sponge Rubber

S/V Ceremuls—Help maintain cell-wall structure, aid sun-check resistance.

Redclaim Oil

S/V Sovaloid N—Produces dense, tacky stocks.

General Process Oils

S/V Sovaloids A Special & W—Plasticizers for natural rubber, GR-S, Neoprene.

METALS



Rust Prevention

S/V Sova-Kotes—Prevent rusting under widely varying conditions.

Quenching

S/V Sova-Quenches—For controlled rate of quench and uniform hardness.

Tempering

Special Oils—Resist oxidation in tempering operations.

AGRICULTURE



DDT Solvents

S/V Sovacides—To make concentrated DDT solutions for general application.

DDT Fogging

S/V Sovacide F—Unique DDT solvent for outdoor use.

Tree Sprays

S/V Sovasprays—Base Oils for dormant and verdant spray emulsions.

Weed Killer

S/V Agronol A—General herbicidal work and pre-emergence control.

Selective De-Weeding

Sovason 5—Kills weeds, but leaves carrots, celery, parsley and certain other vegetables unharmed.

Rust Prevention

S/V Sova-Kotes—Protect farm equipment from corrosion.

PEST CONTROL



Fumigation

S/V Sovacide 544-C—DDT Solvent for indoor fogging. Gives quick "knock-down." Can be used without staining.

Black Flies

S/V Sovacide F—DDT Solvent for outdoor fogging.

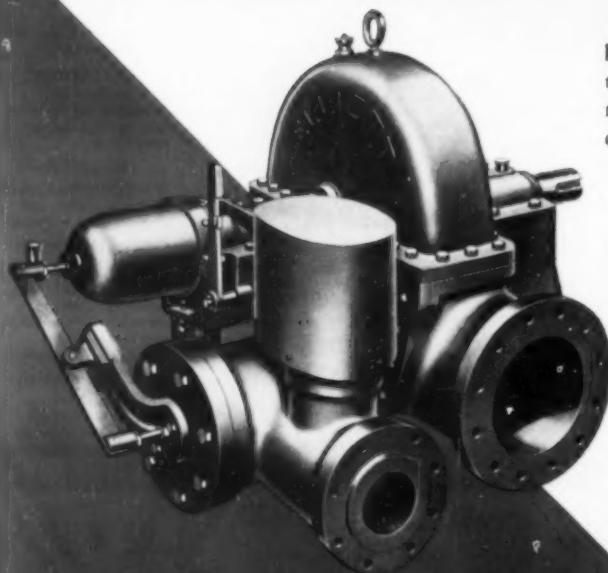
Mosquitoes

S/V Sovacide 544-B—For high-pressure aerosol bombs. S/V Sovacide 544-C—For low-pressure aerosol bombs.

Both strong in

YR Turbines

ELLI



This turbine makes friends everywhere, in all industries, for its tailor-made adaptability, its simplicity, its extremely reliable performance, its surprisingly low maintenance—all qualities of highest value. Capacities to 2000 hp. Speeds, 800-7000 rpm.

YR Turbines are built on a production basis, but engineered to allow an extremely wide range of modifications to meet specific conditions. Here are some of them:

- Five frame sizes —
- Eight different turbine types —
- Your choice of several governors each independent of the standard overspeed governor —
- Six elective control devices, including:
 1. Two hand valves controlling nozzleing
 2. Hand-operated speed changer
 3. Remote control speed changer, air or electric
 4. High exhaust pressure trip
 5. Remote control electrical trip
 6. Hand throttled emergency trip valve.
- Gland seal piping for condensing operation, or operation with gas —
- Exhaust connection on either side.

ELLIOTT

STEAM TURBINE DEPT. • JEANNETTE, PA.

FACILITIES JEANNETTE, PA. • RIDGEWAY, PA.

DISTRICT OFFICES IN

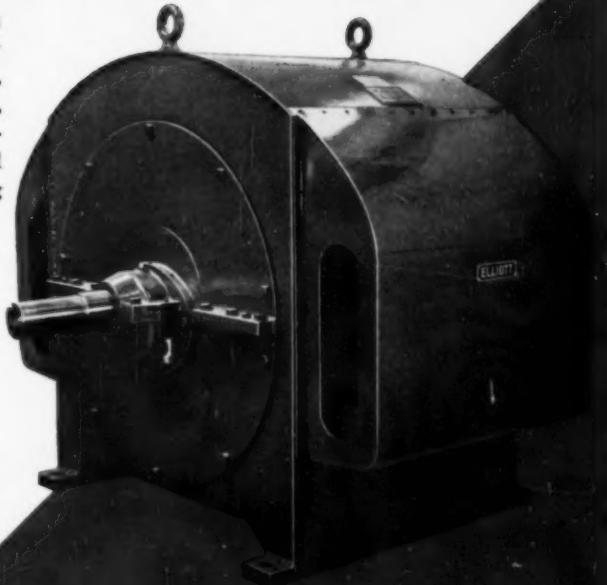
adaptability!

OTT

Fabri-steel motors

● Fabri-steel motors have established an entirely new set of standards in their easy applicability to individual conditions, some of them most difficult. For instance, the standard Elliott squirrel-cage induction motor, without change in electrical design, can be supplied with the following enclosures:

1. Outdoor splashproof
2. Vertical outdoor splashproof
3. Indoor splashproof
4. Frame modified for top discharge
5. Enclosed self-(base) ventilated
6. Totally enclosed, fan-cooled with top-mounted air-to-air heat exchanger
7. Totally enclosed, water-cooled with side-mounted air-to-water heat exchanger
8. Round frame for mounting inside a duct system with a forced-draft fan impeller mounted on tapered shaft extension.



Above is shown the Elliott splash-proof squirrel-cage induction motor, designed for outdoor motors, and proven immune to the effects of rain, sleet, hail, fog, snow, sand, dust and temperature extremes. This motor provides more economy in cost of housing, eliminating need for enclosure in locating installations. It requires no special foundation beyond a simple concrete slab. This model is typical of Elliott advanced thinking in motor engineering.

Get complete data on this and other models from:

Company

DEPT. CE, RIDGEWAY DIVISION • RIDGEWAY, PA.

AMERICAN B. & F. SPRINGFIELD, O. • NEWARK, N. J.

PRINCIPAL CITIES

POWERS for Heating and

PNEUMATIC CONTROL SYSTEMS



POWERS Design for MODERN CONTROL PANEL

In the unique functional design of this Control Panel are integrated various types of POWERS pneumatic controlling, indicating and recording instruments. It masterminds the operation of four complete year round air conditioning systems in the modern plant shown on the next page.

Photos at left and top and bottom of next page show air conditioning systems regulated by the Control Panel. Arrows indicate Powers controls.

Photo below, left—shows four refrigerator compressors, one for each air conditioning system; photo right—Powers air compressor and pilot valves supplying air pressure for control system.



Air Conditioning

Assure Superior Performance
at Lowest Cost for
Operation and Maintenance



Room Thermostat for Offices

POWERS TEMPERATURE and HUMIDITY CONTROL SYSTEMS

prevent OVER-heated air in offices, factories, process rooms and other spaces. Comfortable, healthful room temperature

★ Increases Output of Workers—Over-heated air hastens fatigue, causes mistakes, accidents, increases colds, absenteeism and reduces production.

★ Cuts Heating Costs up to 25%—Keeping each room at its proper temperature prevents waste of fuel from OVER-heating.

Constant Temperature and Humidity conditions in each room can be maintained at any predetermined point with Powers control. It can be installed in existing as well as new buildings.

25 to 40 Years of Dependable Service with very low maintenance cost is reported by hundreds of users. Powers control is notable for its continuous accurate performance.

Precision Control for Processes—Wherever product uniformity and quality are dependent upon precise temperature and humidity regulation, use Powers controlling, indicating or recording instruments.



New modern plant commemorating 60th anniversary of The Powers Regulator Co., pioneer in pneumatic operated controls for heating, air conditioning systems and industrial processes.

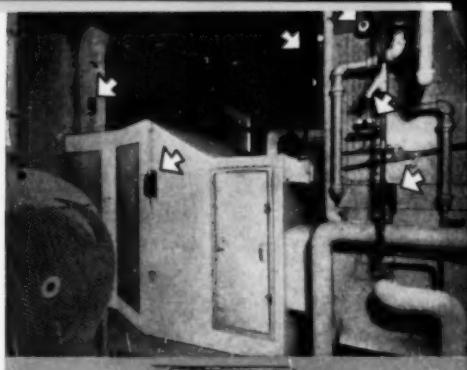
Phone or write our nearest office for help in selecting the type of automatic control that will give best results for your requirements. There's no obligation.

THE POWERS REGULATOR CO.

Established 1891 • SKOKIE, ILLINOIS • Offices in Over 50 Cities

CHICAGO 13, ILL., 3819 N. Ashland Ave. • NEW YORK 17, N. Y., 231 E. 46 St.
LOS ANGELES 5, CAL., 1808 W. 8th St. • BOSTON 15, MASS., 125 St. Botolph St.
DETROIT 1, MICH., 2631 Woodward Ave. • TORONTO, ONT., 195 Spadina Ave.
PHILADELPHIA 32, PA., 2240 N. Broad St.

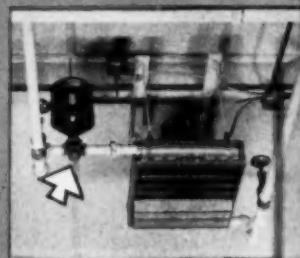
(nfb)



POWERS

Above: Arrows indicate some of the many controls applied to air conditioning system: Powers Duct Hygrostat, Duct Thermostat, Pneumatic Switch, Diaphragm Valves and Damper Motors; Static Pressure Regulators, etc.

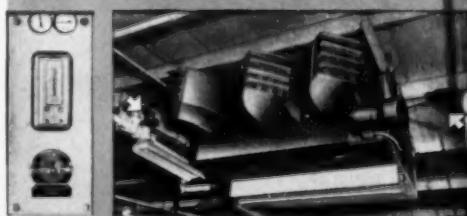
Photo at right shows ceiling-type unit heater used in factory. It is controlled by wall type thermometer which automatically regulates Vulcan flat-top radiation below windows.



Left: Instrument panel for Powers MASTROL System of forced hot water temperature control for heating.



Below: Factory fresh air ventilating units heat and filter outdoor air, providing two air changes per hour in winter and ten in summer.



POWERS



The better the valve,
the less it will
require maintenance

With Powell, it's not "how many" but
"how good." Powell Valves are so good
that they operate more efficiently, last
much longer, and require far less main-
tenance. In short, Powell can give you
flow control at its best.

There's a greater variety of Powell valves in
use today than of any other individual make.

The Wm. Powell Company
Cincinnati 22, Ohio

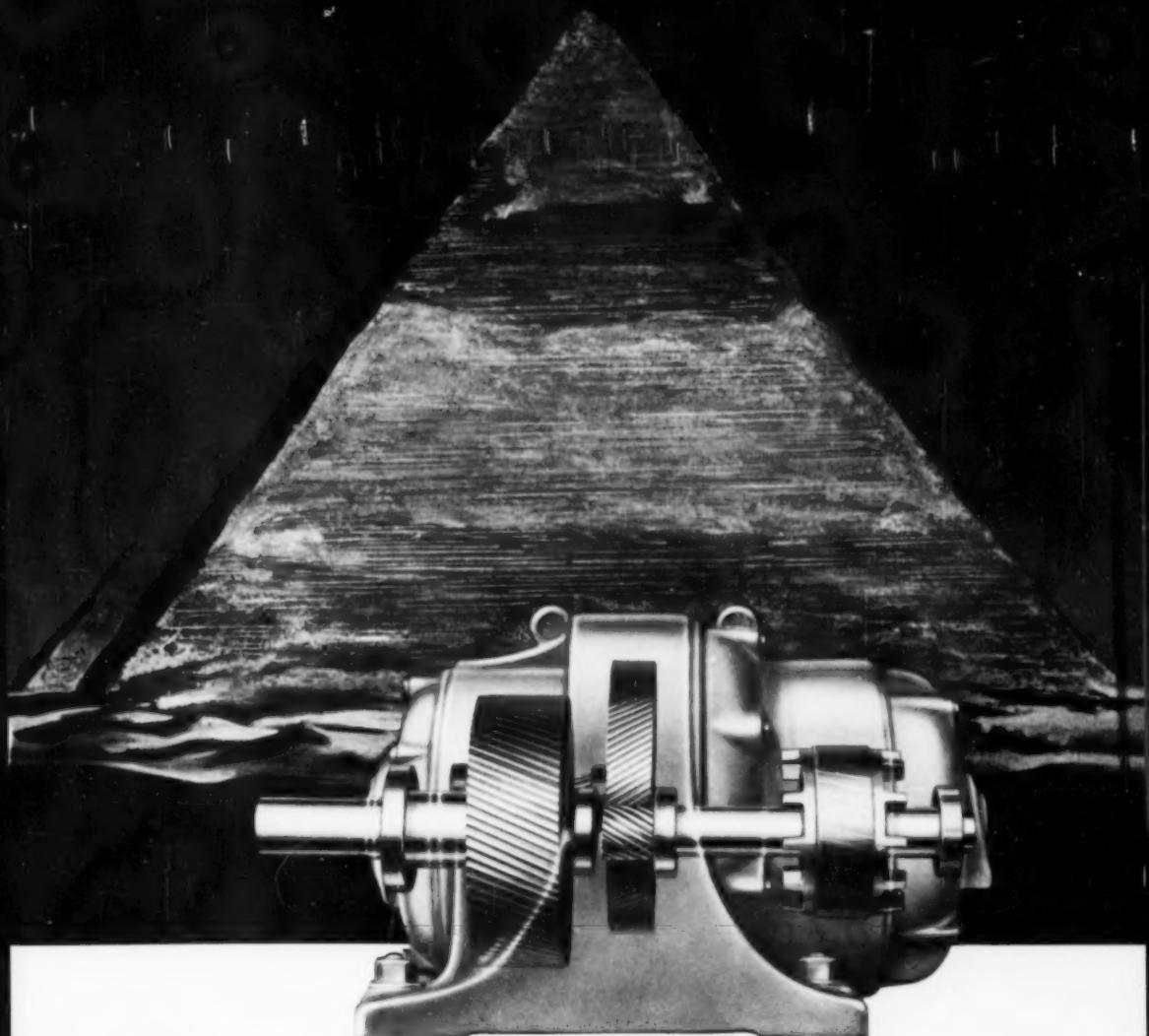
Fig. 375—200-pound
Bronze Gate Valve with
reversible, wear-resisting
Powellular-nickel-
bronze disc.

POWELL

BRONZE, IRON, STEEL AND CARBON STEEL VALVES



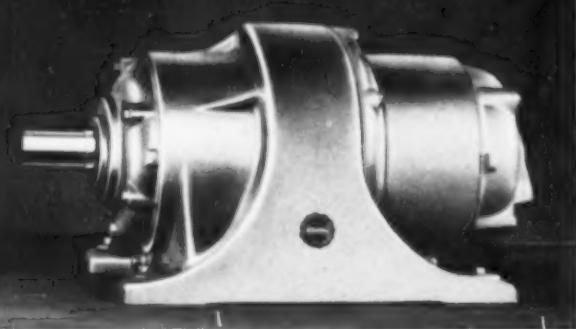
DURABILITY



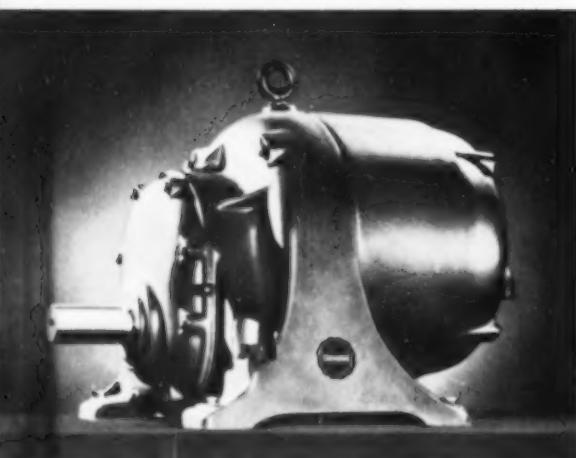
U. S. SYNCROGEAR MOTOR



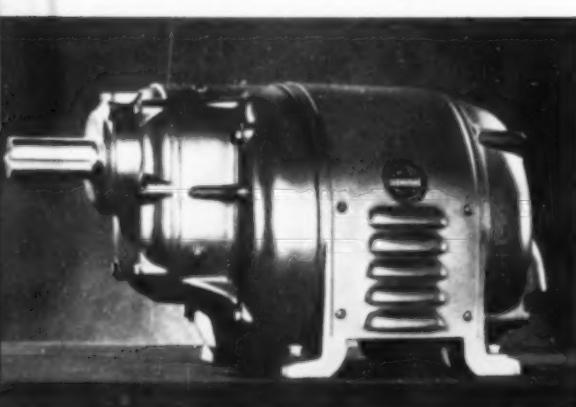
*The internally-gearred motor with **PYRAMIDAL** stability*



Type GD - U. S. Syncogear Motor, Double Reduction



Type GR - U. S. Syncogear Motor, Single Reduction



Type GM - U. S. Syncogear Motor, Single Reduction and Speed Increaser

MAIL SCRAPER FOR DESCRIPTIVE BULLETIN

U. S. Electrical Motors Inc., C.E.

Box 2058, Los Angeles 54, Calif. or Milford, Conn.

Send your new Bulletin illustrating and describing Syncogear Motors.

Also General Bulletin of all U. S. Motors.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____

ZONE _____ STATE _____

SIMPLIFY

WITH

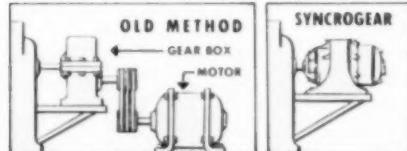
SYNCROGEAR

THE INTERNALLY-GEARED MOTOR

When you need geared power for slow speeds or heavy loads, use this simple hook-up—the *U. S. Syncogear Motor*. Instead of installing a motor plus gear box or exposed gears, extra coupling and belting, you can direct connect this motor.

The Syncogear motor is internally-gearred within a pyramidal structure which is extremely rigid. Gearing is maintained in perfect alignment and completely enclosed within a sealed housing, protected from dust, dirt and other contaminants. All castings are normalized. The motor windings are asbestos-protected to resist carbonization. The gears are hardened to Rockwell C 45/50 to insure longest life. Dip-splash lubrication automatically feeds the correct amount of lubricant and insures cool gear operation regardless of load.

SAVE SPACE



Note the compact setting of the U. S. Syncogear Motor. It occupies practically no more space than a standard motor. Its integral design saves space so that equipment designers can reduce over-all dimensions and eliminate extra gearing and intermediate connections.

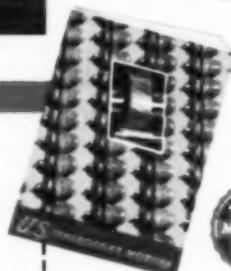
U. S. MOTORS

U. S. ELECTRICAL MOTORS INC.

PACIFIC PLANT: Los Angeles 54, Calif. (P. O. Box 2058)

ATLANTIC PLANT: Milford, Conn.

Atlanta 3, Ga.; Bakersfield, Calif.; Boston 16, Mass.; Chicago 8, Ill.; Cincinnati 16, Ohio; Cleveland 14, Ohio; Dallas 9, Texas; Detroit 2, Mich.; Fresno 1, Calif.; Houston 4, Texas; Indianapolis 4, Ind.; Milwaukee 2, Wisc.; Minneapolis 2, Minn.; New York City 6, N. Y.; Philadelphia 2, Pa.; Pittsburgh 2, Pa.; San Francisco 7, Calif.; Seattle 4, Wash. Sales and Service offices in all principal cities.



Some Things Are WORSE THAN STRIKES

This editorial which appears in McGraw-Hill publications was written just prior to the resignation of Charles E. Wilson as Director of Mobilization. The principle it discusses is of basic and continuing importance in our struggle to maintain economic and personal freedom in America.

It is to be hoped that the managements of the steel industry will resolutely resist the efforts of the national Wage Stabilization Board to force them to establish the union shop in their plants. In essence, the union shop means compulsory union membership.

They should resist not because of any financial advantage to the owners of the industry. There would be none. They should resist out of a decent regard for those ideals of our country which we are now fighting in Korea to protect. Moreover, their resistance would, as a matter of fact, benefit the leaders of the organized steel workers by protecting them from the certain and bitter fruits of their "victory" in getting the government to impose the union shop on the steel industry. Their successful resistance would also prevent Premier Stalin and his co-workers from enjoying a hearty laugh at our expense.

Fun for the Russians

This is why the Politburo would find the establishment of the union shop in the steel industry, at the behest of the Wage Stabilization Board, so profoundly amusing. We are fighting in Korea because we believe that armed aggression, promoted by Russia, menaces our freedom. And we are spending hun-

dreds of billions of dollars here at home for armament to protect our freedom at other danger points. When this rearmament program is threatened by a crippling strike, the federal government through its Wage Stabilization Board proposes to buy off the threat by plowing under a vital element of that freedom which we are trying so desperately to preserve.

When the union shop is adopted through voluntary agreement, as it has been in cases covering millions of workers, it deeply undercuts the freedom of the individual. To hold his job he is required to join the union and support it financially whether he wants to or not. In the case of such voluntary agreement, however, the government takes no direct part in thus destroying the freedom of its citizens. It is essentially a private transaction.

Tyranny is the Word

But in the steel case the federal government becomes a party to a direct attempt to impose the union shop. Instead of protecting its citizens in their right to earn a livelihood, the government forces certain of them to join and support a private organization which they have clearly indicated they do not want to join. This they must do to hold their jobs. Tyranny is the accepted designation of government coercion of this kind.

It may be objected that the Wage Stabilization Board merely recommends the union shop, does not order it. This was also true of the action recently taken by a President's Emergency Board, which also "recommended" that working agreements between the

railroads and about a million non-operating railroad employees include a provision for the union shop. A government recommendation, however, can easily be given much of the force of an order, particularly by the calling of a strike to "uphold the hand of the government."

It seems entirely clear that in trying to impose the union shop on the steel industry the Wage Stabilization Board has completely lost its bearings. It was set up to handle labor problems to tide over an emergency. Now it comes up with a revolutionary modification of labor relations in the steel industry which, if adopted, would become a permanent part of the institutional machinery of the industry.

"Too Much Like Hitler"

Early in World War II an effort was made to have the federal government order the union shop for a group of organized coal miners. President Franklin D. Roosevelt, who will go down in history as one of organized labor's greatest champions, blocked it. "That," he said, "would be too much like the Hitler methods toward labor." But now, with supreme irony, the federal government fosters this Hitlerlike method toward labor ostensibly to advance our conflict with Stalin.

In persuading the Wage Stabilization Board to sponsor the union shop for steel workers, there is every reason to believe that the union leaders have trapped themselves. If the government imposes the union shop, a next step clearly becomes necessary. This is government regulation of the union in order to provide a modicum of protection for the minority that would be forced by the government to join against their will. It could be that for a time the government would ignore this obligation. But, having granted the union the power to eliminate the minority, it would sooner or later be forced to regulate the use of that power. Thus free collective bargaining and freedom itself would be the losers.

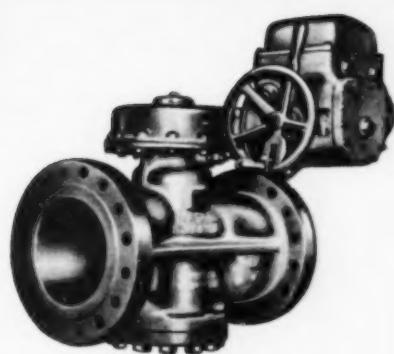
An Issue of Basic Principle

Resistance to a government-sponsored union shop for the steel industry is bound to bring harsh denunciation both from the administration and union leaders who have teamed to back it. Not only does the union shop relieve the union leaders of the problem of recruiting members, it also eliminates a group of workers that they stigmatize as "free riders"—namely, those who work for companies which have a working agreement with a union but do not join the union. In the basic steel industry about 10 per cent of those who work for companies with union agreements are not members of the union. Such a small percentage of non-members is obviously no threat to the "security" of the union, although that is what the drive for the union shop ostensibly is designed to protect.

In the reporting of the present labor dispute in the steel industry virtually all of the attention has been focussed on the handling of the issue of a wage increase and how large it should be. This, to be sure, is vitally important. Mobilization Director Wilson has said it is "a serious threat to our year-old effort to stabilize the economy." But certainly of comparable importance is the tremendous issue of principle raised by the government's backing of the union shop for the steel industry.

If the position of the Wage Stabilization Board on the union shop prevails, our government will have blunted the arms we are forging to fight for our freedom abroad by undermining a major bulwark of our freedom right here at home. At this critical time in the struggle to preserve and protect our freedom such a subversive course should be resisted to the limit.

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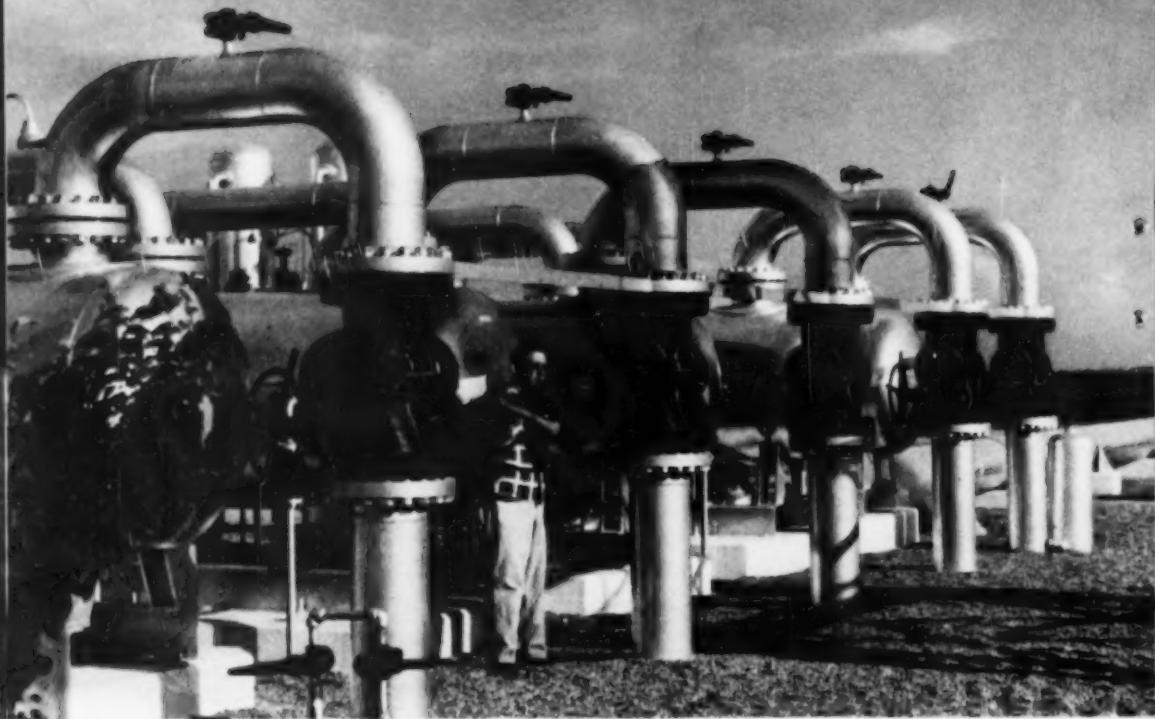
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Nordstrom Valves

Another  Product
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NOW WITH NORDSTROM You Can Centralize and Mechanize Flow Control

With Nordstrom automatic control valves a single panelboard operator can completely command all lines of flow. From one location, he can tell at a glance which lines are open and which are closed. In an emergency, operation is instant. Complex batching and blending processes, dependent upon timed cycles, become simple. Manpower is saved. Valves miles away can be operated at the touch of a finger.

Nordstrom power operated valves enable you to mechanize your flow control and centralize flow line operation.



From Field to Flame Through Nordstrom Valves

At each stage, from the time it comes from the ground, through processing, pipe line, distribution and finally use, natural gas is controlled by Nordstrom valves.

The same can be said for petroleum.

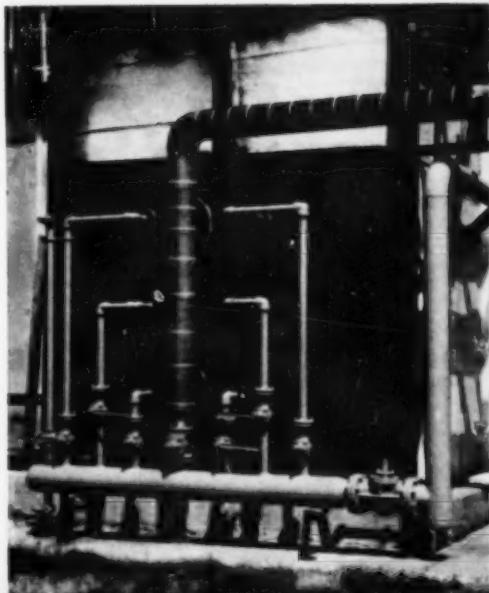
The same can be said for many chemicals.

Nordstrom valves have been used successfully in perhaps more different kinds of difficult services than any other type of valves. You find them in virtually all types of industrial process lines.

Why?

Because, with the original Nordstrom internal lubrication system they seal tighter, open more easily under pressure, let flow straight through, and have no gas—or fluid catching pockets to start corrosion or erosion.

Nordstrom valves and Nordstrom service are available by distributors everywhere. Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.



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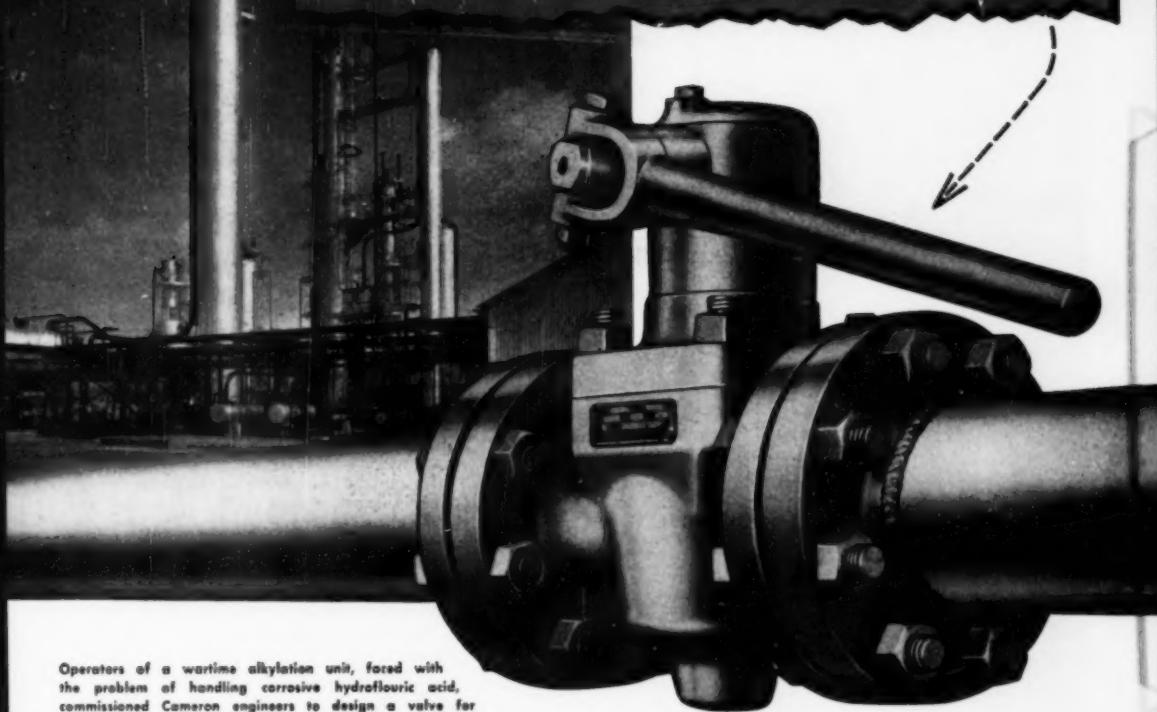


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tailor-made for you!*



Operators of a wartime alkylation unit, faced with the problem of handling corrosive hydrofluoric acid, commissioned Cameron engineers to design a valve for that specific service. The Cameron Non-Lubricated Lift-Plug Valve is the result. It combines the best features of conventional valves with such innovations as a separate, renewable seat and a unique plug actuator which, in $\frac{1}{4}$ -turn of the operating lever, lifts the plug free of the seat, then rotates the plug to open or closed position, and reseats the plug. The separate seat not only permits any desired trim for specific services and facilitates maintenance of the valve, it also provides a seat for the plug which does not distort with the body due to line strains. Consequently, no lubricant is required either to effect a seal or for easy operation.

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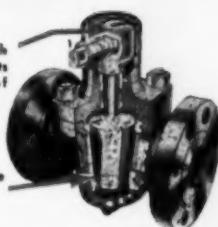
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NON-LUBRICATED
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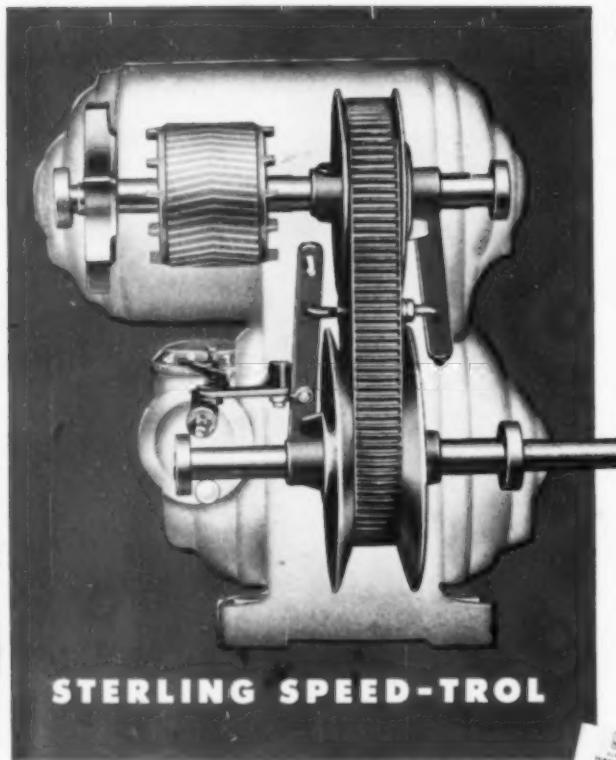
Plug actuator which
lifts, turns, and seats
plug in $\frac{1}{4}$ -turn of
operating lever.



Separate, renewable
seat.



MACHINE PRODUCTIVITY INCREASED 25% WITH



STERLING SPEED-TROL!

We have been using Speed-Trols for a number of years to power the agitators of chemical mixing tanks at our Woodbridge, N. J., plant, reports Mr. M. B. Hart of The Hart Products Corp. Since replacing overhead shaft, pulley and belt drives with Speed-Trols, we have increased output 25%; improved quality of product; reduced costs of labor, maintenance and power; improved plant safety and employee morale; cut space requirements 20%.

STERLING SPEED-TROL GIVES YOU VARIABLE SPEED CONTROL NECESSARY FOR:

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With Speed-Trol you get the maximum in production, plant efficiency, quality and profit.

OUTSTANDING FEATURES:

Infinite speeds—positive speed regulation—fingertip control—large indicator—positive pulleys—no springs—belt tension in proportion to load—protected—streamlined—Herringbone Rotor—through ventilation—versatile mounting—NEMA dimensions—shock absorbing—quiet operation—rugged—compact—dependable—long life.



70 ILLUSTRATIONS showing how Sterling Electric Power Drives reduce production costs. Write for Bulletin No. B 119

STERLING

ELECTRIC MOTORS

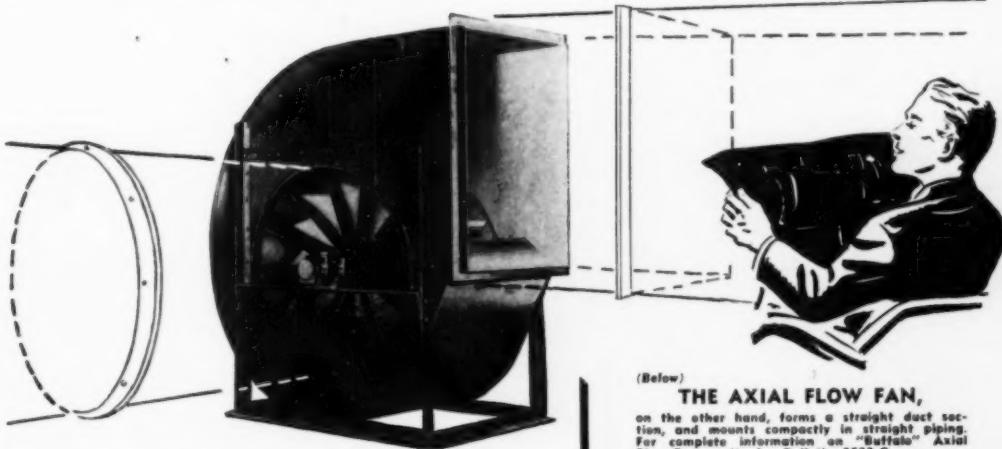
Plants: New York City 51; Van Wert, Ohio; Los Angeles 22; Hamilton, Canada; Santiago, Chile.

Offices and distributors in all principal cities.

The Buffalo logo features the word "Buffalo" in a stylized, flowing script font, enclosed within a triangular border.

Tips on Getting the Best Service from your Fans

PICK THE FAN TO SUIT THE PLAN!



The CENTRIFUGAL FAN Is A Built-in 90° Elbow

Since air leaves the centrifugal fan in a direction vertical to that of the entering air, the logical location of the fan is where a 90° turn in the duct is planned. This takes advantage of the natural right-angle change in direction of the air and does not sacrifice efficiency, as in forcing air through an ordinary elbow. "Buffalo" Limit-Load centrifugal fans like the one shown above have features for additional efficiency and quiet, such as double backward curve blades, directional inlet vanes, specially shaped housing and dynamically balanced wheels. Medium speed fans, they are ideal for handling large volumes of air at medium pressures. They have the additional advantage of being non-overloading, regardless of system pressure.

(Below)
THE AXIAL FLOW FAN,
on the other hand, forms a straight duct section, and occupies compactly in straight piping.
For complete information on "Buffalo" Axial Flow Fans, write for Bulletin 3533-C.



TO HELP YOU SELECT THE RIGHT FAN—

Bulletin 3737 gives construction and performance data on "Buffalo" Limit-Load fans.
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VENTILATING
FORCED DRAFT

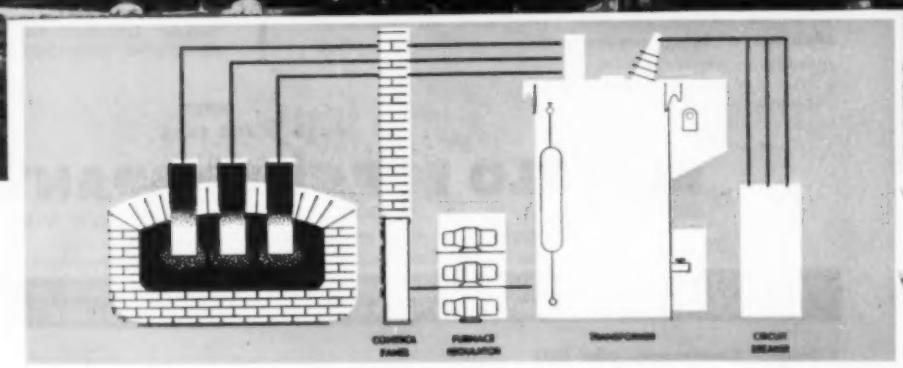
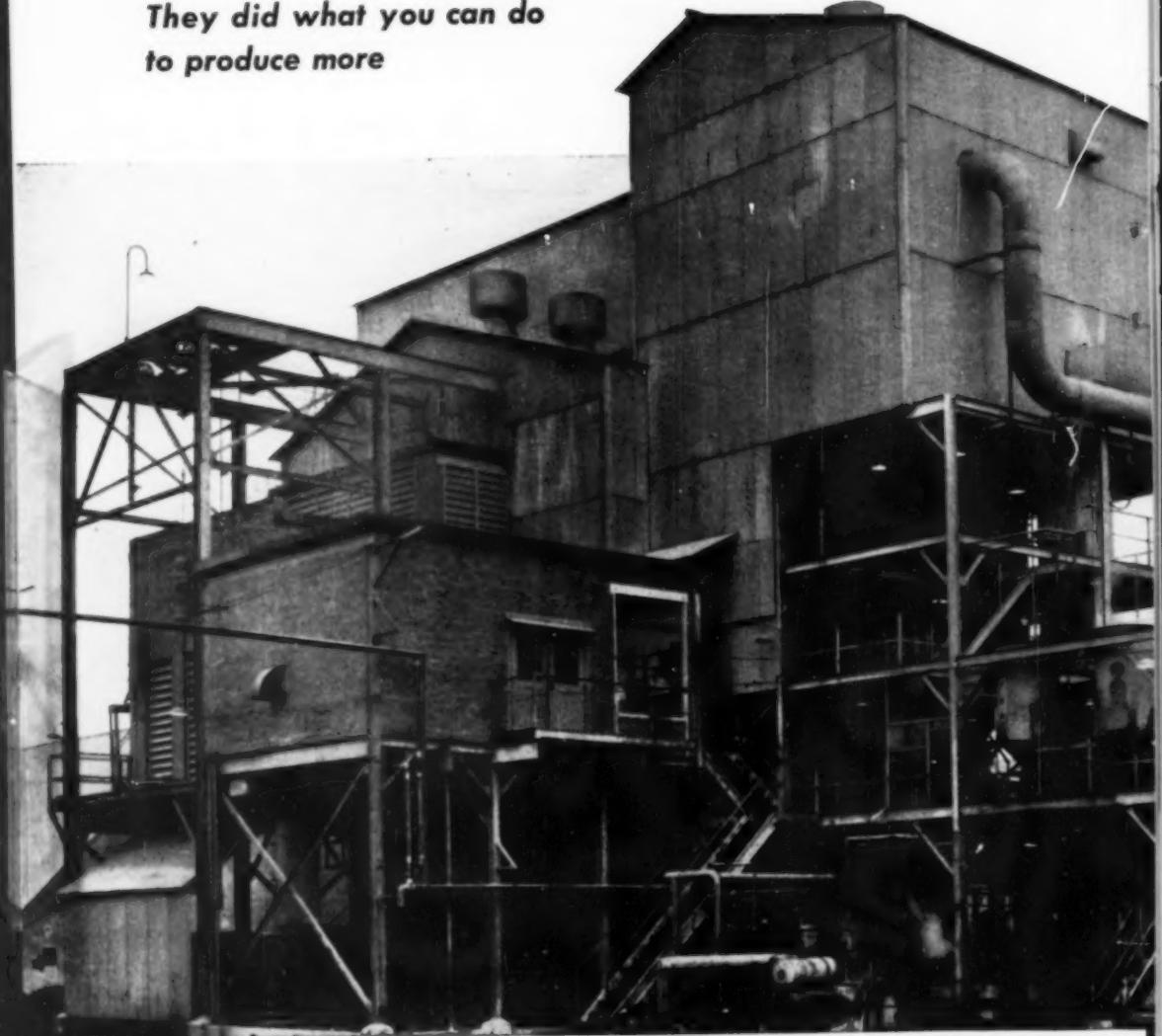
AIR CLEANING
COOLING

AIR TEMPERING
HEATING

INDUCED DRAFT
PRESSURE BLOWING

EXHAUSTING

**They did what you can do
to produce more**



How the right Arc Furnace Equipment keeps costs down

Here's a case where a relatively small plant is one of the industry's lowest cost producers. It's the Virginia-Carolina Chemical Corporation's new electric furnace operation at Charleston, S. C., for the production of phosphorus.

Power efficiency is 10% above normal

The biggest operating cost item is electric power (30 to 35% of total operating costs) so they planned the electrical system carefully and had Westinghouse help. First they designed for an unusually high operating voltage. This increased power efficiency 10% and also boosted furnace capacity. In effect, the high voltage lengthens the *reaction zone* in the furnace and thus increases production per kwhr.

Rototrol runs furnace automatically

The furnace operation is controlled automatically by Westinghouse Rototrol®. It maintains the desired electrochemical conditions by continuously moving the carbon electrodes up and down within the boiling charge. When any electrochemical unbalance occurs, Rototrol smoothly restores proper conditions without overshooting.

System designed for high power factor

Smart planning also resulted in a high power factor for the unit and this further reduced power bills. The whole electrical system is highly dependable because of the experience Westinghouse brings to furnace equipment design. More Westinghouse arc furnace equipment is in use than all other makes combined.

Call Westinghouse on your next project

This project is typical of the engineering assistance and equipment Westinghouse applies to chemical processes. When your next project comes up, call Westinghouse *early* in the planning stage.

FREE BOOK ON ARC FURNACE EQUIPMENT

If you're interested in arc furnace production, write now for this free book "Westinghouse Equipment for Electric Arc Furnaces", B-4693. It tells how you can increase output, get more dependable production. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania.

J-94886



YOU CAN BE SURE...IF IT'S
Westinghouse

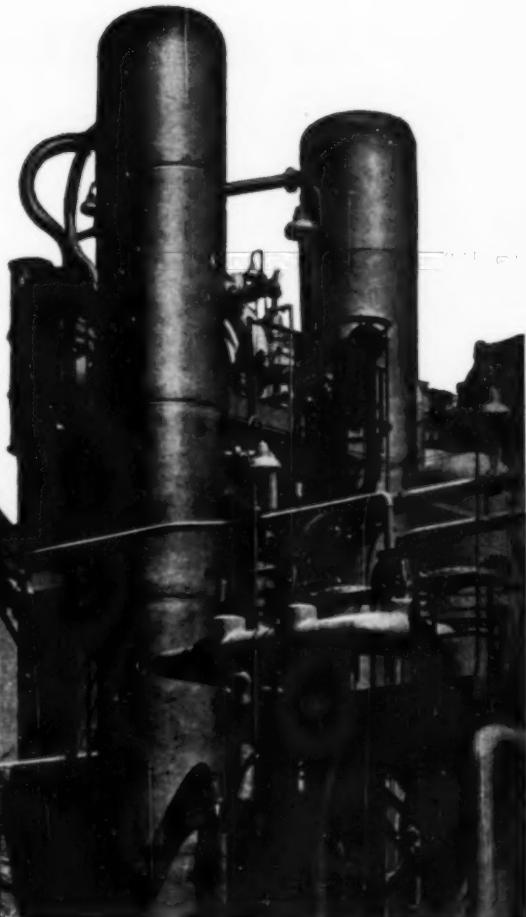


EQUIPMENT FOR
CHEMICAL PROCESSES

What's U. S. Rubber doing to prevent corrosion?



ROYALGUARD PROTECTIVE COATING has excellent resistance to weather. It will not crack or chip. It is ideally suited to protect chemical processing equipment, tanks, tank cars, pipes, fittings, structural steel parts and machinery.

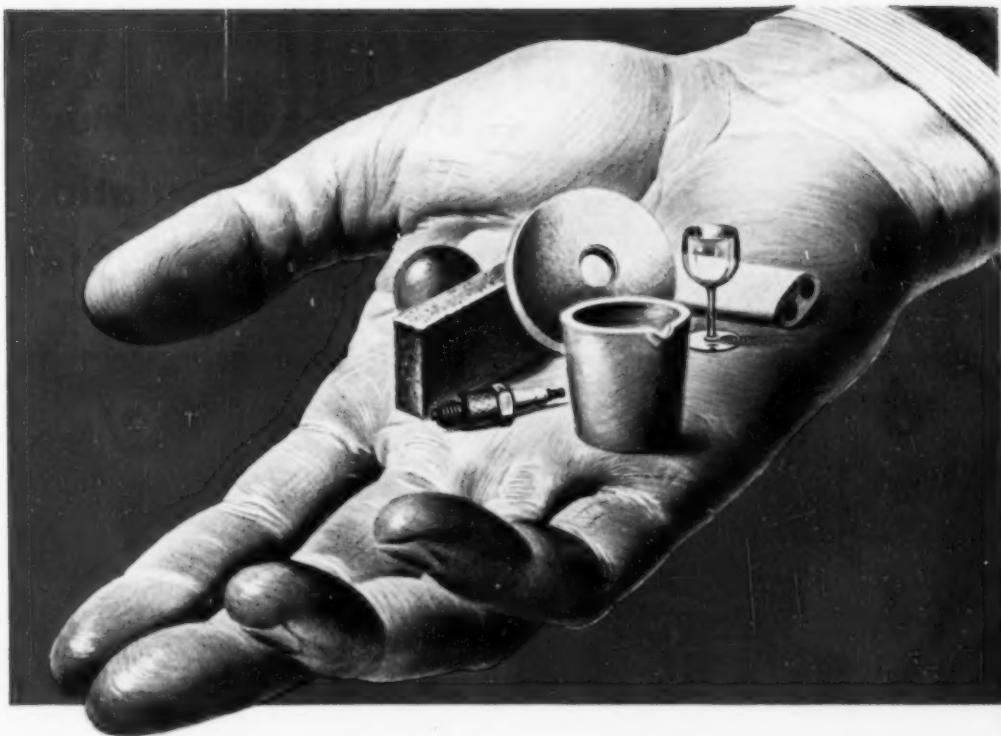


U. S. Royalguard, the new, remarkable protective coating, is a wonderful defense against corrosive attack. Sprayed on surfaces of steel, aluminum, concrete, hardwoods, Masonite and Transite, it provides effective resistance against a wide range of chemicals. Royalguard reduces maintenance and replacement costs. It has high film flexibility and adhesion qualities, becomes tack free rapidly at room temperatures, has excellent reverse impact resistance, requires no primer. For more information about Royalguard write to address below.

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If calcined or hydrated aluminas are important to your product's quality, you'll be in dependable hands when you order from Kaiser Chemicals.

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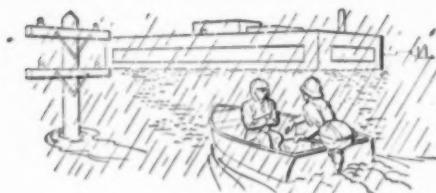
CALL US TODAY. We'll be on the job the minute you say the word. Principal sales offices: Chemical Division, Kaiser Aluminum and Chemical Sales, Inc., 1924 Broadway, Oakland, California. First National Tower, Akron, Ohio.

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Alumina • Basic Refractory Bricks and Ramming Materials • Dolomite • Magnesia • Magnesite • Periclase
CHEMICAL ENGINEERING—May 1952

CAUGHT IN A FLOOD

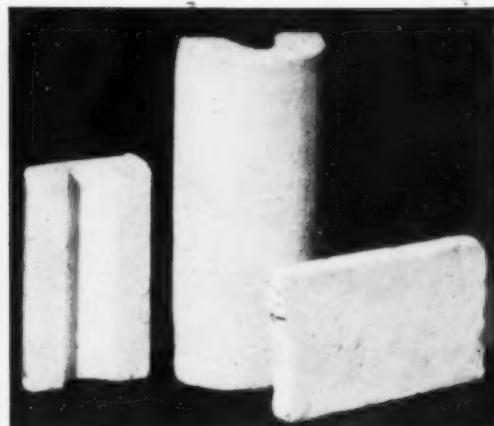


...Dug Out of the Mud,
Kaylo Heat Insulation
Proved Still Usable!



WATER SOAKED AND CAKED WITH MUD, these three pieces of Kaylo Heat Insulation were found partially buried in the Kansas City, Missouri, warehouse of Procter & Gamble after nearly two weeks of Missouri River flood water had receded. The unretouched photograph above shows the wet and mud covered pieces as they looked on arrival at the laboratories in Toledo, Ohio after shipment in a loosely-packed carton.

Kaylo Heat Insulation is a hydrous calcium silicate—the heat-saving material that is revolutionizing insulation practice with its outstanding combination of advantages.



THE SAME THREE PIECES are shown in this unretouched photograph after they were cleaned by holding them under a water faucet and rubbing by hand, then dried with an electric fan. These pieces are still usable—*proof* of Kaylo Heat Insulation's resistance to water damage. Other Kaylo Heat Insulation, already installed at this plant, was under water during the flood, yet is still in place and performing efficiently.



WRITE FOR FREE BOOK—"Kaylo Heat Insulation." Address: Dept. N-259, Owens-Illinois Glass Company, Kaylo Div., Toledo 1, Ohio.

KAYLO

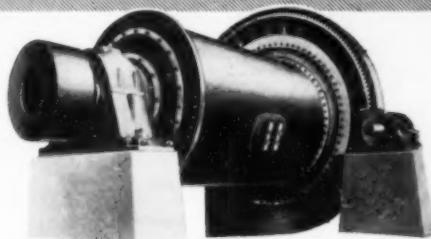
... first in calcium silicate

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A modern Traylor Grinding Mill, built for modern rates of production.

For 50 years, Traylor has worked with leading producers to develop machinery that will get the most out of modern advances in techniques and methods. The right solution to any grinding problem is essential before a large investment in equipment is made. It takes experience to provide the right answer. Traylor has experience . . . half a century of it. Use it to your advantage.



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Century
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Century type TEFC protected type motors are very popular in the chemical and food processing industries for resisting rust and corrosive fumes. They are widely used in the metal working industries to protect the vital parts against abrasive dust or gritty oil fog.

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Totally Enclosed Fan Cooled Motors*

- Smooth exterior surfaces — easy to clean.
- Cast iron frame resists rust and corrosion.
- Rugged construction — safety factor for rough handling.
- Integral cast iron steel fan corrosion when mounted in locations where processed material may contact the heat.

who must keep your Production Turning, knows how to evaluate the inside of the Motor. Ask him about these Century Construction features.



- Vital parts of motor protected — sealed-in inner frame.
- Reverse direction of motor without changing fan — Fan runs in either direction.



- Uniform ventilation — surrounding outside of inner frame.
- Smooth straight-through ventilating passages.
- Winding electrically insulated 6 different ways.



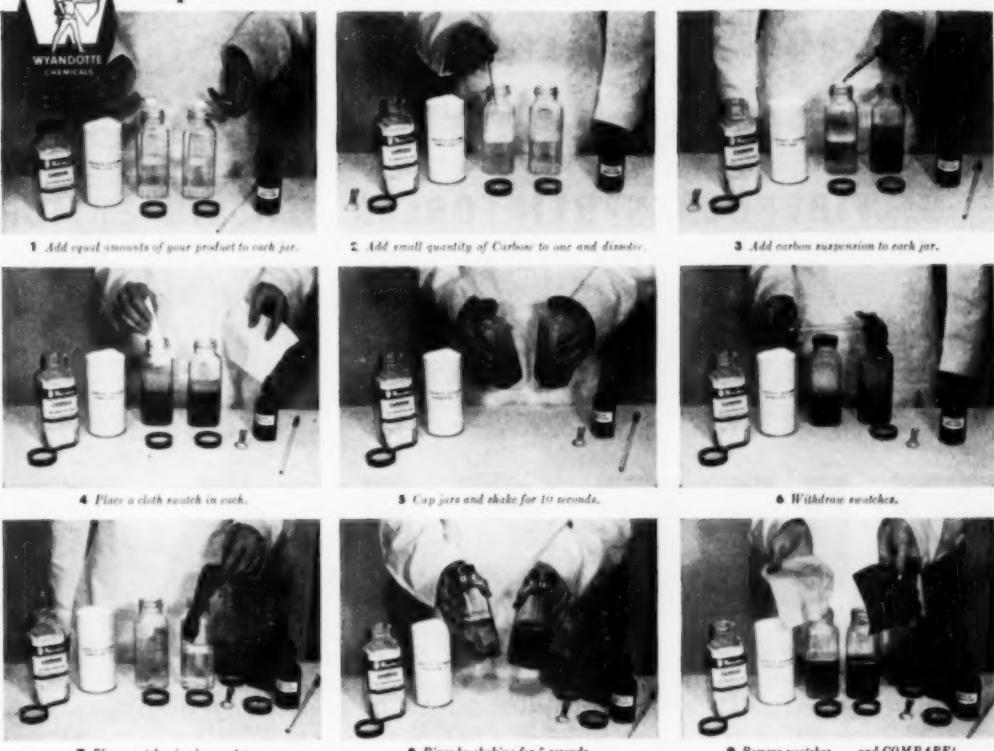
- Uniform rotor winding — high pressure cast aluminum.
- Ball bearing housing keeps grease "in" — dirt "out" — lubricated for several years' normal service, with grease plugs where you want to lubricate bearings.



- Easy to remove fan guard for inspection — 2 screws hold steel fan guard in place.



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Whether your soap process is continuous or batch kettle . . . whether you're making dishwashing or bleaches, Wyandotte has a grade of caustic that will satisfy your needs. Samples and information available upon request.

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It's no surprise. In carefully controlled tests on cotton, this outstanding "detergency promoter"—as little as 1%—increased soil removal and whiteness retention as much as 10% to 40% in different formulations with synthetic detergents and builders. CARBOSE promotes long-lasting suds, reduces skin irritation—ideal for dishwashing, car-washing and other compounds where emolliency is desirable.

This superior product is typical of Wyandotte. For the quick facts on

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FOR SOAPS AND DETERGENTS

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TUFCLAD

For problems involving severe corrosion or freedom from metallic contamination, the chemical processing industry has found no more effective—or economical—material than Lapp Chemical Porcelain. Now this same solid porcelain material is available with TUFCLAD, a new *tough* armor which greatly adds to operating security—protection of personnel and equipment—certainty of avoiding product loss.

TUFCLAD is woven Fiberglass fabric, impregnated and bonded in multiple layers to the porcelain body with a special modified phenolic resin of high strength and chemical and heat resistance. Armor is tightly knit to porcelain and runs end-to-end, *under* flanges.

In operation, TUFCLAD provides a cushion to protect porcelain against accidental damage in handling or operation—and an insulator against thermal shock.

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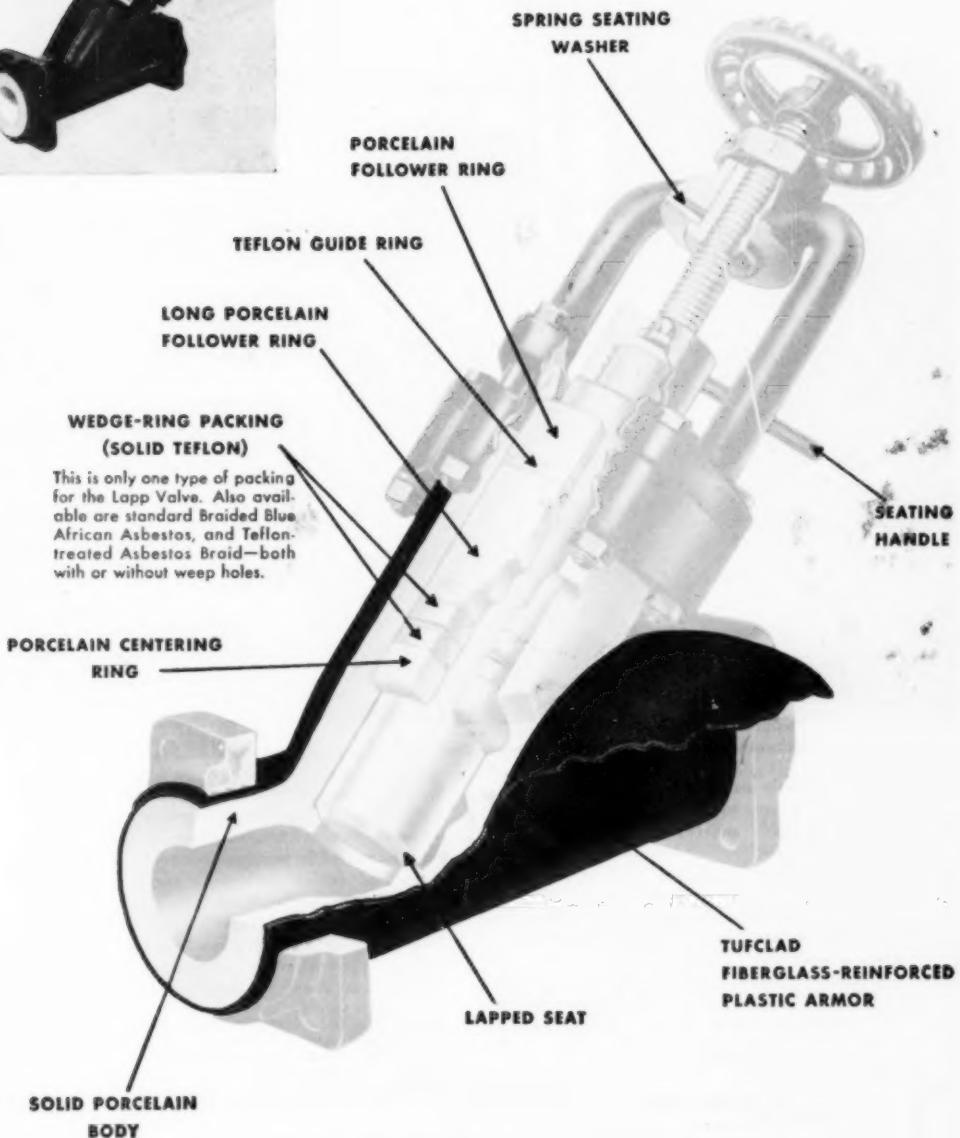
You can achieve the purity and freedom from corrosion in processing with solid Lapp porcelain—together with operating security—with Lapp TUFCLAD Porcelain. Write for description and specifications of Lapp TUFCLAD-armored Porcelain valves, plug cocks, safety valves, flush valves, pipe, fittings and special shapes. Lapp Insulator Co., Inc., Process Equipment Division, 502 Maple Street, Le Roy, N. Y.

Lapp

PROCESS EQUIPMENT

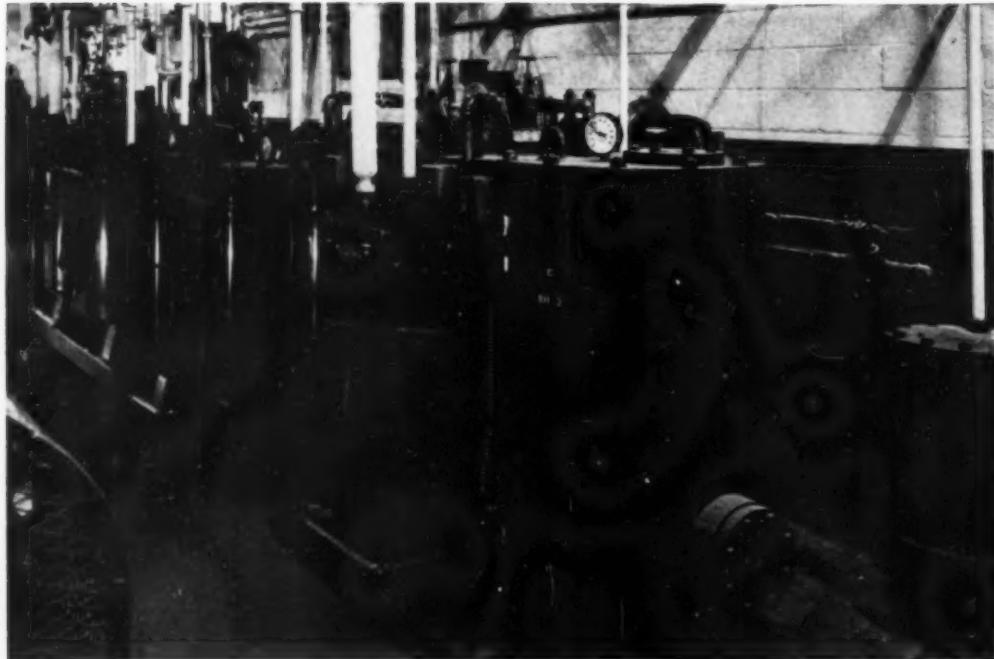
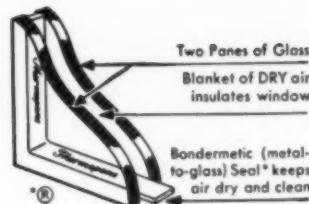
CHEMICAL PORCELAIN VALVES • PIPE • RASCHIG RINGS

PULSAFEEDER CHEMICAL PROPORTIONING PUMPS



L-O-F assembles DRY air and glass

in making *Thermopane**



These three Lectrodryers in L-O-F's plant at Toledo, Ohio, DRY compressed air before it passes into their lines

Air, permanently sealed between the glass panes, that makes *Thermopane* such an effective heat insulator, is DRY air. No moisture to cause fogging at low temperatures.

Libbey - Owens - Ford Glass Company obtains that DRYness by flushing the space between the panes with DRY air until all moisture is removed to a dewpoint below -30° F. Three Lectrodryers* DRY that air.

Even in "ordinary" plants, compressed air dried

DRY by Lectrodryers saves time and money. No long waits while the water, that separators let by, drains out of air lines. No blushing, rust—or mud spotting when air is used for paint and enamel spray guns. No clogging of delicate instrument ports or excessive wearing of air-operated equipment.

Lectrodryer engineers will gladly help apply Lectrodryers to your compressed air systems. Write Pittsburgh Lectrodryer Corporation, 303 32nd Street, Pittsburgh 30, Pennsylvania.

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In France: Stein et Roubez, 24 Rue Erlanger, Paris XVI.
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LECTRODRYERS DRY
WITH ACTIVATED ALUMINAS

LECTRODRYER

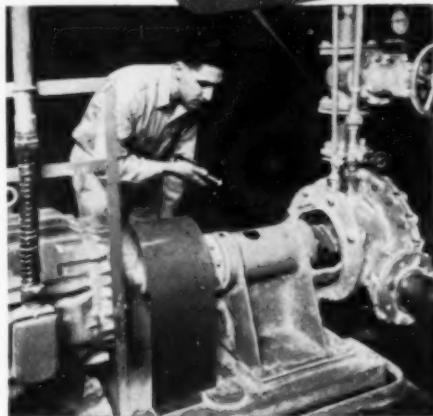
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Equisel
stuffing box stops
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heads up to 15 feet



ALLIS-CHALMERS PROCESS PUMPS



IF YOU MUST STOP LEAKAGE because of sanitation or corrosion . . . or if abrasives in the stuffing box make it hard to keep a packing in your process pump . . . you need an Allis-Chalmers Type PD Process Pump with *Equisel* stuffing box. Within its range, the *Equisel* stuffing box keeps the pumped liquid entirely out of the packing. The liquid cannot leak out while the pump is running, even if the packing is removed. Abrasives cannot enter the stuffing box to ruin the packing.

HOW IT WORKS

The *Equisel* stuffing box arrangement consists of an auxiliary impeller which produces a low pressure area in front of the stuffing box. At 1750 rpm, pressure on the pump side of the stuffing box is zero for suction heads up to fifteen feet and is reduced fifteen feet where the suction head is higher.

If you have leakage or excessive packing wear problems, you should know more about the Allis-Chalmers Type PD Process Pump equipped with the *Equisel* stuffing box. To get complete information, call your Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wis., for Bulletin 08B6615.

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	<p>D.O.James Gear Manufacturing Co. is constantly developing and continuing to improve its variety of gear speed reducers — enabling engineers and designers of power-saving equipment to meet and cope with space limitations, horsepower requirements, ratios, location of driven or driving shafts and the type of drive that the many and varied installations require. Catalogs are available containing complete informative engineering data that will assist in the selection of the type of reducer for the specific job to be done.</p>		
	<p>D.O.JAMES GEAR MANUFACTURING CO. Since 1888—Makers of Cut Gears, Gear Reducers and Flexible Couplings 1140 W. MONROE STREET • CHICAGO, U. S. A.</p>		



MORE ROUND TRIPS ...with safety and savings

A Hackney 2-Piece Acid Drum will keep coming back for refills long after you would expect to retire a conventional 3-piece constructed container. That's because it is built stronger to last longer. Just look at these outstanding advantages, and see for yourself:

I-Bar Rolling Hoops—two 1" x 1½" hoops take the handling shocks—protect seam and bung from damage.

Heavy Forged Spuds—attached by a two-pass weld—minimize bung failures.

Reinforced Chime Protectors—add extra strength and life.

Two-Piece Construction—eliminates chimes and longitudinal seams. Formed from two seamless, cold drawn shells, joined by a single circumferential weld.

Controlled Heat-Treating—relieves weld and forming stresses—increases resistance to corrosion.

Smooth Interiors—free from crevices, cracks and scale—are always easy to clean.

Choose Hackney 2-Piece Acid Drums for safe, low-cost shipments of sulphuric acid, aqua ammonia, caustic potash, hydrofluoric acid or other special chemicals. Write for full details.

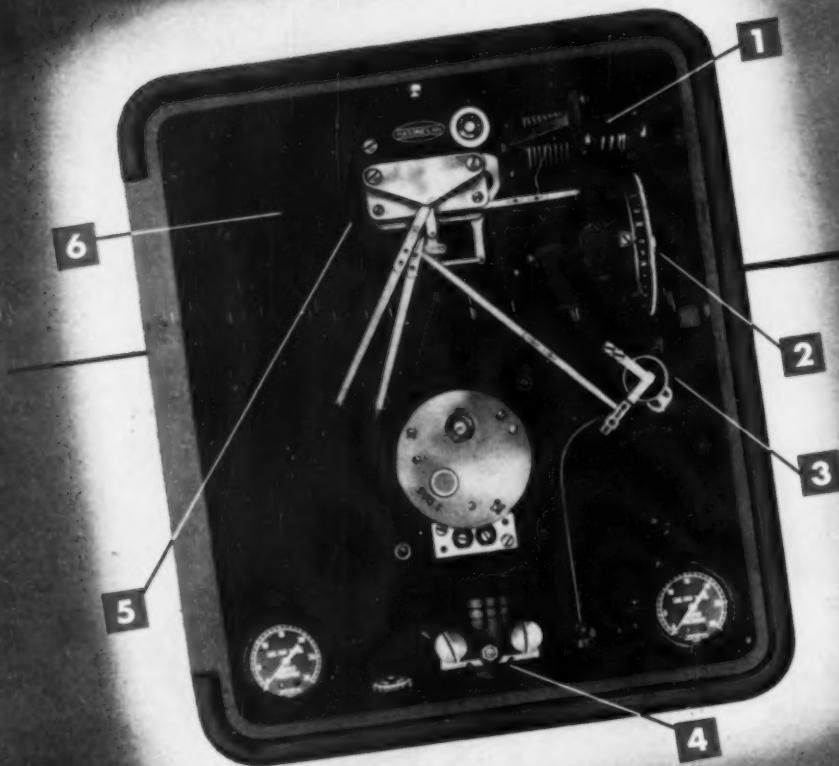
Pressed Steel Tank Company

Manufacturer of Hackney Products

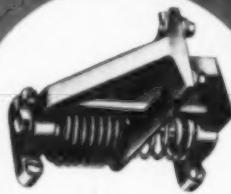
1447 S. 66th Street, Milwaukee 14 • 1325 Vanderbilt Concourse Bldg., New York 17 • 203 Hanna Bldg., Cleveland 15
936 W. Peachtree St., N.W., Room 113, Atlanta 3 • 208 S. LaSalle St., Room 792, Chicago 4
553 Roosevelt Bldg., Los Angeles 17



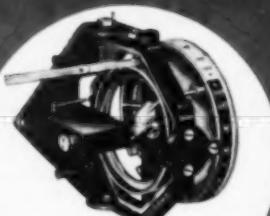
CONTAINERS FOR GASES, LIQUIDS AND SOLIDS



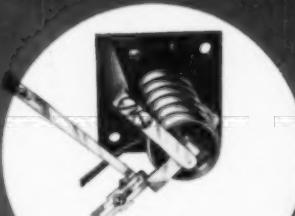
MARONEILAN 60000 SERIES PNEUMATIC CONTROLLER



1. PROPORTIONAL UNIT
interchangeable with
proportional-
reset unit.



2. GIMBAL UNIT
combines primary and feed-
back motions — basic
in all controllers.



3. PRIMARY ELEMENT
helical or spiral bourdon,
or bellows as
required.

A HIGH **CQ** PRODUCT

MASONEILAN

The New Masoneilan "6-in-1" Controller IS SIMPLE AS A B C

One Setting of basic "6-in-1" controller

selects on-off, proportional, or differential-gap control; direct or reverse action; proportional band or differential-gap setting.

Easy to Set, Adjust, Test and Service —

all settings made without removing chart; all subassemblies complete and directly accessible; all air passages manifolded; four-position transfer switch in manual control subpanel.

Easy to detach and interchange subassemblies

from backplate-manifold to vary desired control function; for cleaning or servicing.

Available Now for Prompt Delivery



4. RELAY PILOT
with cleanable orifice and
integral filters.



5. PEN MOVEMENT
includes gearless index
setting.



6. BACKPLATE-MANIFOLD
supports subassemblies; con-
ceals, supports, tubing;
eliminates fittings.
(Rear View)

MASON-NEILAN REGULATOR CO.
1197 ADAMS STREET, BOSTON 24, MASS., U.S.A.

Sales Offices or Distributors in the Following Cities:

New York • Syracuse • Chicago • St. Louis • Tulsa • Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland
Cincinnati • Detroit • San Francisco • Salt Lake City • El Paso • Boise • Albuquerque • Charlotte • Los Angeles
Denver • Appleton • Corpus Christi • New Orleans • Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

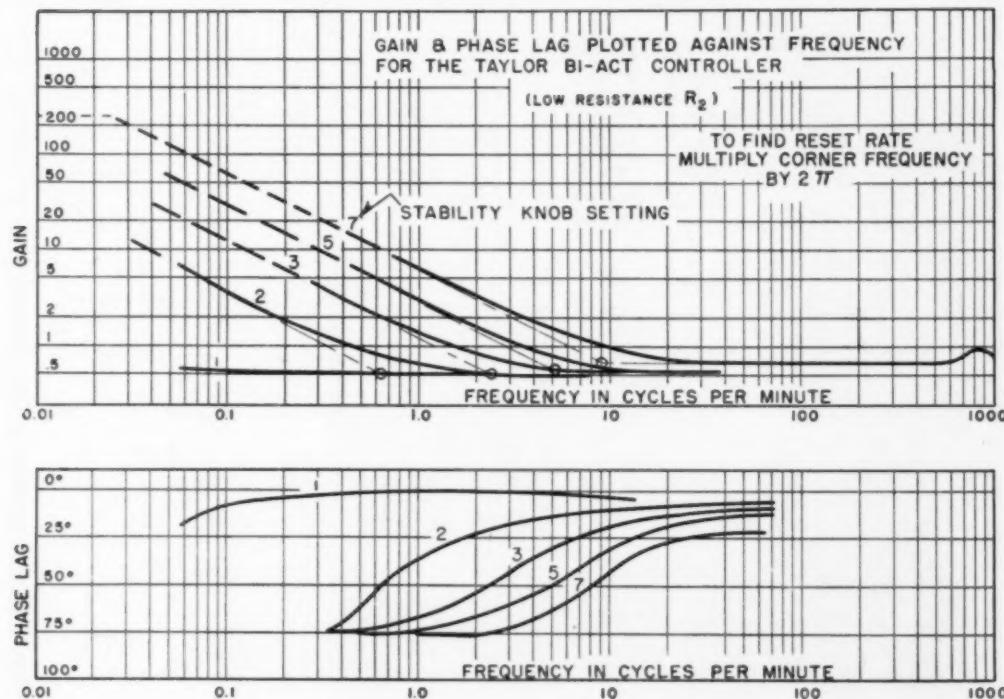
Two ways the new Taylor

1. BY THESE DISTINCTIVE FEATURES:



to describe Bi-Act* Controller

2. BY FREQUENCY RESPONSE ANALYSIS:



The above graphs describe the Bi-Act Controller designed for use in industrial processes with short time lags such as close-coupled liquid flow, fast pressure and comparable temperature problems.

Send for Bulletin 98097 describing the TRANSET Control System, or any of the following papers: "Frequency Response Analysis" . . . "Frequency Response Data on Bi-Act Controllers"

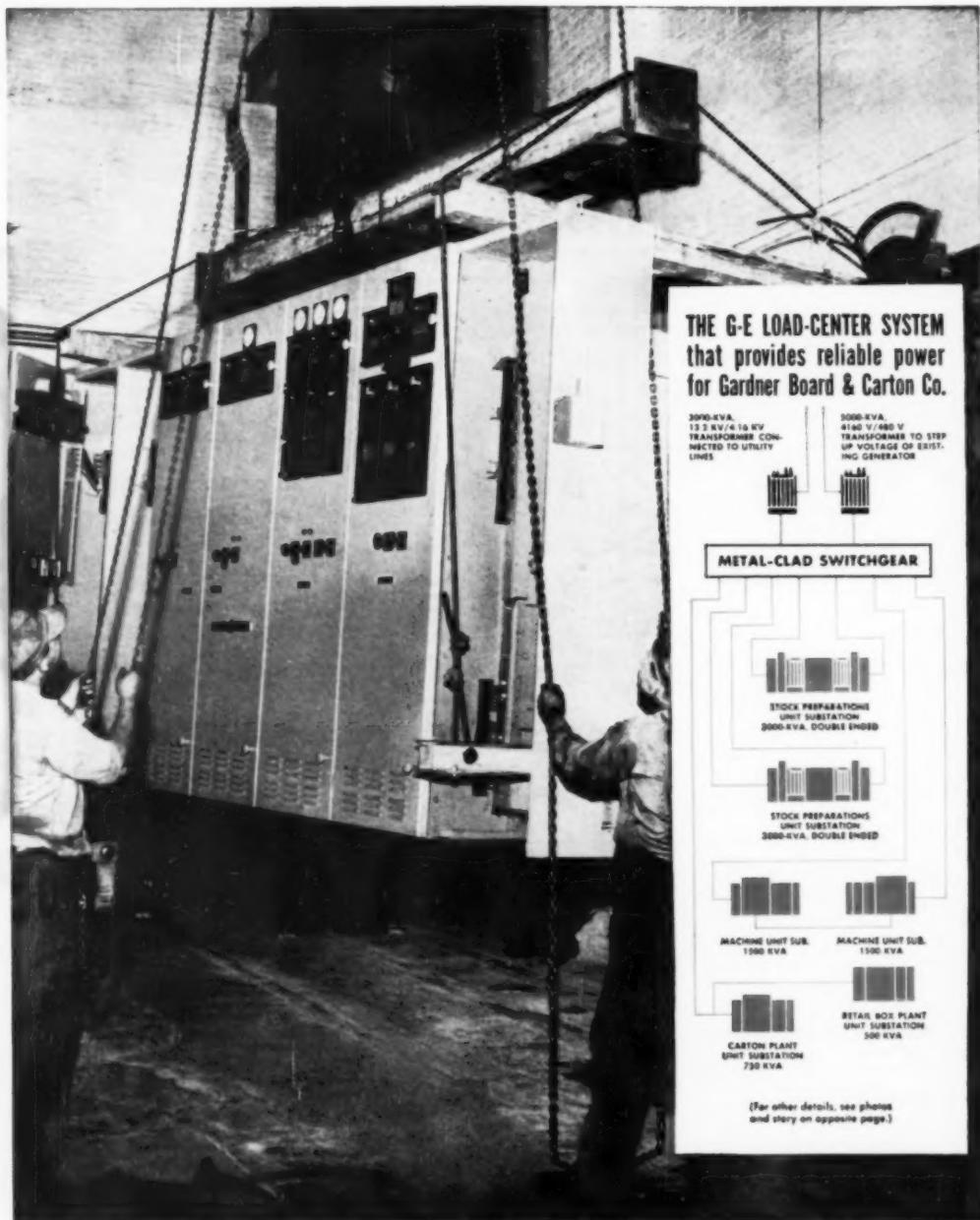
Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

* Trade-Mark

Taylor Instruments
— MEAN —
ACCURACY FIRST

IN HOME AND INDUSTRY

Ohio plant avoids shutdowns with



THE G-E LOAD-CENTER SYSTEM
that provides reliable power
for Gardner Board & Carton Co.

3000-KVA.
13.2 KV/4.16 KV
TRANSFORMER CON-
NECTED TO UTILITY
LINES

5000-KVA.
4160 V/480 V
TRANSFORMER TO STEP
UP VOLTAGE OF EXIST-
ING GENERATOR

METAL-CLAD SWITCHGEAR

STOCK PREPARATIONS
UNIT SUBSTATION
3000-KVA. DOUBLE EMBED

STOCK PREPARATIONS
UNIT SUBSTATION
3000-KVA. DOUBLE EMBED

MACHINE UNIT SUB.
1500 KVA

MACHINE UNIT SUB.
1500 KVA

CARTON PLANT
UNIT SUBSTATION
750 KVA

BIG BOX PLANT
UNIT SUBSTATION
300 KVA

(For other details, see photo
and story on opposite page.)

G-E FACTORY-ASSEMBLED POWER EQUIPMENT IS EASY TO INSTALL. HERE MEN LOWER MAIN SWITCHGEAR SECTION INTO PLACE.

G-E load-center power system



Like many other growing plants, the Gardner Board and Carton Co. found they needed more power. They realized, too, a pressing need for more protection against power-failure shutdown than they had with their old-type 480-volt distribution system.

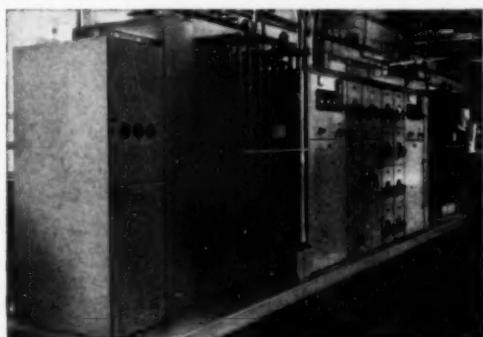
How they did it: With the help of General Electric engineers, Gardner completely replaced their old 480-volt system with a modern 4160-volt G-E load-center system. Compact, metal-enclosed unit substations now give them plenty of power—and plenty of protection against power shutdowns too. A secondary-selective system provides duplicate sources of power for substations supplying the most vital plant loads. Metal-enclosure of all live parts—and modern breakers with plenty of interrupting capacity—give further protection both for production and for plant personnel.

Improves Voltage—Saves Copper—Flexible for Future By taking high-voltage power directly to load centers, long secondary circuits are avoided, and plant voltage improved. The tons of extra copper that would have been required to expand the old 480-volt system were saved. And the plant electric system now has great flexibility for the future. Additional substations can be added easily, quickly, economically. Existing ones can be easily moved to follow load shifts.

For further information on G-E engineered load centers, call on your local G-E sales representative, or write for GEA-3592, General Electric Company, Schenectady 5, N. Y.

G-E "Project Co-ordination" praised by Chief Engineer

"Many costly man-hours were saved for us by G-E over-all co-ordination," says Arthur Harvey, Chief Engineer of Gardner Board and Carton Co. "From planning to final installation, G-E co-ordinated all equipment and delivery details whereas Gardner men installed the equipment. The effect on our production during this period was negligible." In photo above, Mr. Harvey discusses over-all plan submitted by General Electric with Mr. J. M. Popp, G-E sales engineer. A simple outline of this plan is shown in chart on opposite page.

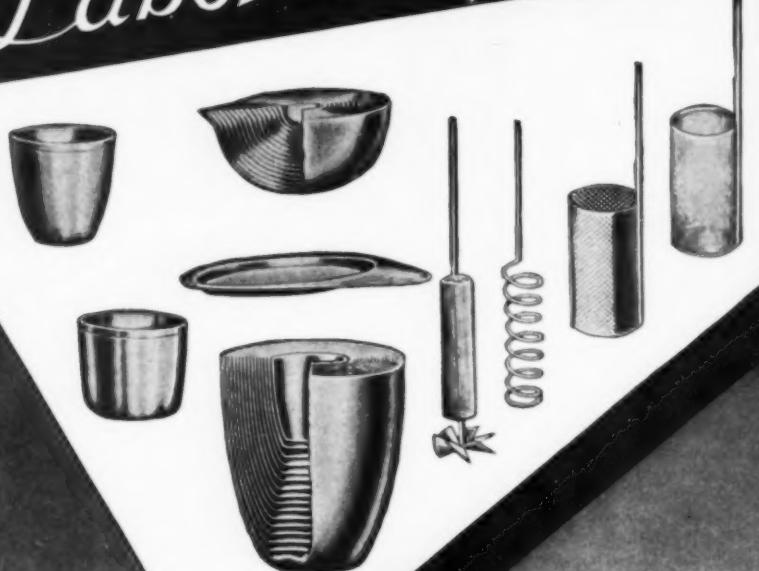


Compact Double-ended Load-Center Unit installed close to load. Ratings: 3000 kva, 4160/480 v. Drawout breakers are easy to inspect, have plenty of interrupting capacity. Note G-E "Interlocked Armor" cables, which provide metal-enclosed circuits with lower material and installation costs.

GENERAL ELECTRIC

323-78

Baker Platinum Laboratory Ware



Production of platinum laboratory ware has been a specialty of ours for almost three-quarters of a century, and we have devoted a great deal of research and experiment to improving it.

This work has been aided greatly by the fact that we maintain and operate large scientific laboratories and use our own platinum ware in them.

Thus, the ware is subjected to day in, day out tests through use, and practical experience has brought about a number of improvements, among which are:

Improvements in metallurgical processes which have increased its useful life — development of the platinum-rhodium alloy which is now so widely used — design changes like the reinforced rim on crucibles and dishes — development of the low form crucible — improvements in the design of platinum electrodes.

You run no risk in making Baker Platinum Laboratory Ware standard equipment.

BAKER & CO., INC.
113 Aston St., Newark 5, N. J.

NEW YORK

SAN FRANCISCO

CHICAGO

**AN INVITATION
to manufacturers
with drying, cooling
or roasting problems...**

LINK-BELT will assist in developing your process



Find the best method for drying, cooling, roasting. It's as easy as sending us samples of your materials. You see, Link-Belt maintains a fully-staffed, scientific, modern laboratory as a service to industry. Take advantage of these facilities . . . there's miniature equipment for small test-runs . . . full-scale set-up for large test-runs.

Even with a small sample, we will test-run your material, work out procedures in the laboratory that can be duplicated in your plant...

Many products become marketable only after commercially practicable drying, cooling or roasting processes have been developed. That's where Link-Belt can give you the answer in advance . . . before you've spent a cent!

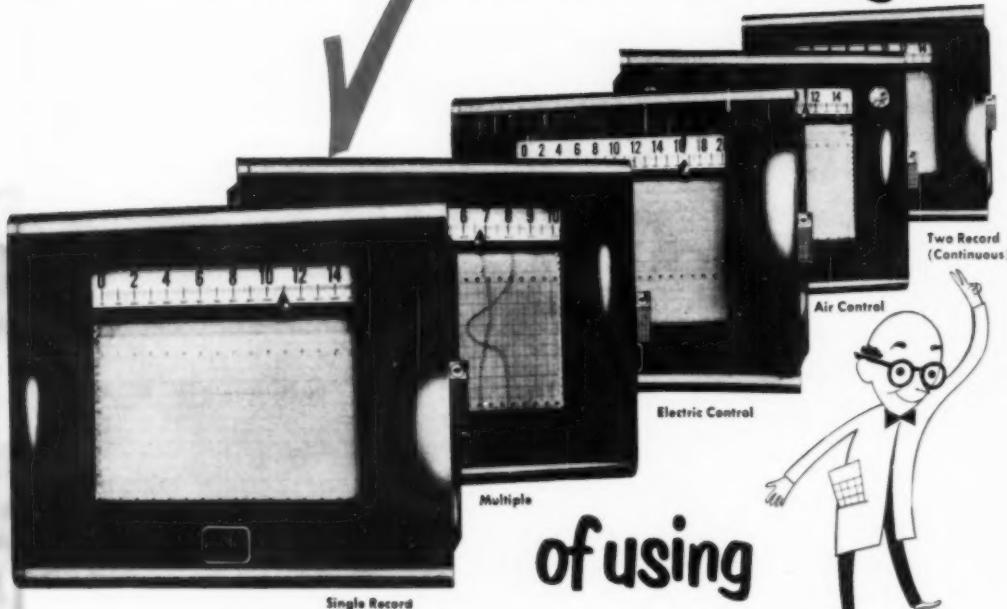
More than 1000 such laboratory tests have already been made. And as a result, 500 Link-Belt Dryers now step up capacity and improve quality of over 100 different products.

Ask for a test of your own materials. If you can't ship samples—ask for a unit on loan to try out right in your own plant. Why not contact your nearest Link-Belt office or plant for particulars? Now!

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities.



CHECK the Advantages



of using the Dynamaster Family

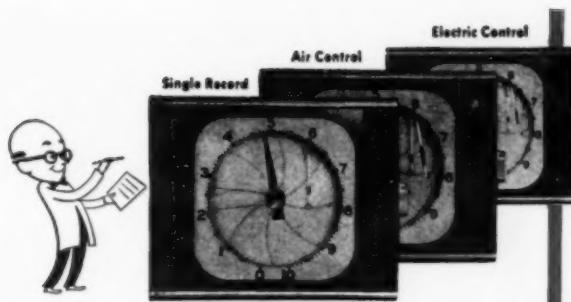
of continuous-balance electronic instruments

Strip chart or circular chart recorders . . . recorders with slow or fast pen speeds and chart speeds . . . single or multiple recorders . . . automatic controllers . . . all in the same case with identical components except the chart-drive mechanisms.

This variety-with-standardization assures you of easier installation, better looking control panels, simpler maintenance. The service man who knows one Dynamaster, knows them all.

BRISTOL

The dependable Guidepost of Industry
AUTOMATIC CONTROLLING, RECORDING AND TELEMETRY INSTRUMENTS



"Everyone who sees these Dynamasters is impressed with clean simplicity of internal design."

You'll be impressed too

WITH FEATURES LIKE THESE...

- Models to measure any variable convertible into d-c voltage, d-c current, resistance, capacitance
 - Continuous-balancing electronic circuit assures instant response
 - All types of electric and air-operated controllers offered
 - Little or no maintenance
 - All models use the same easy-to-replace components
 - Electronic unit uses vacuum tubes available at any radio supply house
 - Full-scale pen travel of 7, 3 or $\frac{1}{2}$ seconds
 - Chart speeds from $\frac{1}{4}$ in. per hour to 7200 in. per hour.
 - Multiple recorders up to 16 points
 - Practically immune to vibration, shock, or external stray currents

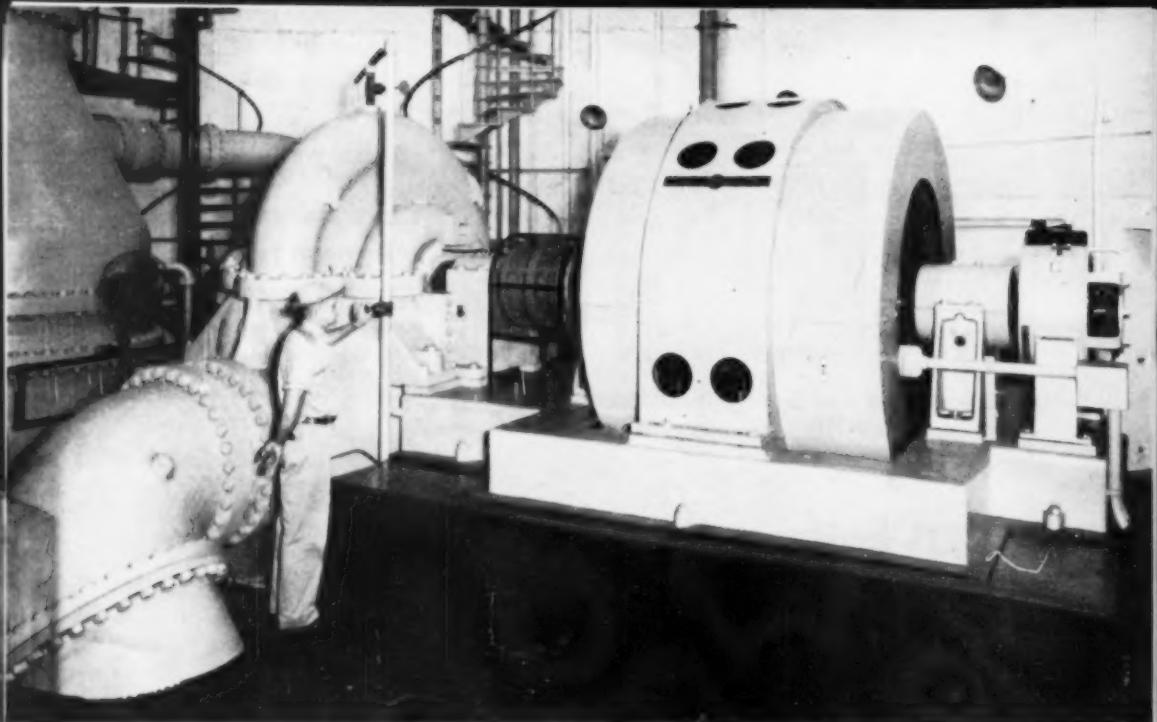
YOU'LL WANT TO GET full details by using
the coupon to order Catalog No. P1245.



COMPANIES LIKE THESE
are using
Dynamasters

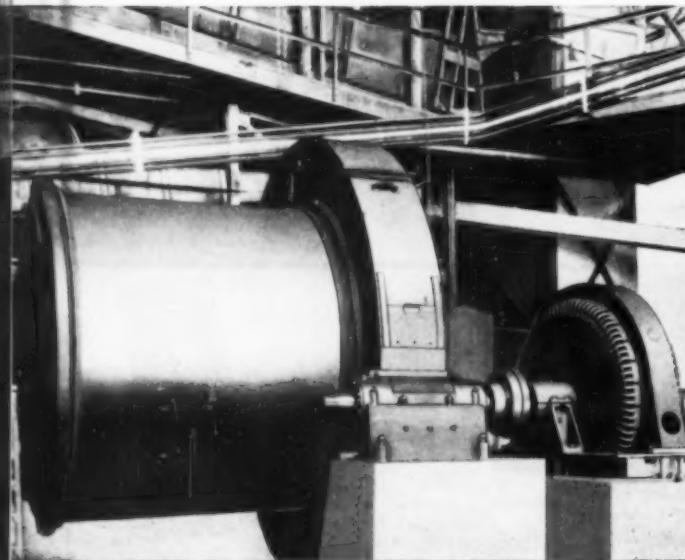
- North American Cyanamid Limited**
Jones & Laughlin Steel Corporation
Ravbestos-Manhattan, Inc.
 Manhattan Rubber Division
Consolidated Edison Co. of New York, Inc.
Friez Instrument Division,
 Bendix Aviation Corp.
Scovill Manufacturing Company
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E. I. du Pont de Nemours & Co., Inc.
Automatic Temperature Control Co., Inc.
Swindell-Dressler Corporation
Woods Hole Oceanographic Institution
Jarrell-Ash Company
National Research Corporation

<p>THE BRISTOL COMPANY 109 Bristol Road Waterbury 20, Conn.</p> <p>Please send catalog giving details of Dynamaster performance to:</p> <p>NAME _____ TITLE _____</p> <p>COMPANY _____</p> <p>ADDRESS _____</p> <p>CITY _____ ZONE _____ STATE _____</p>	
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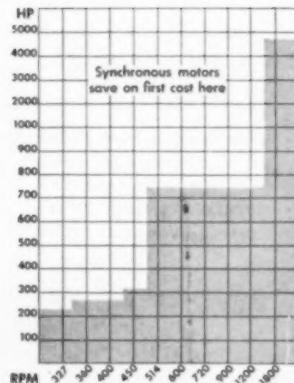


Savings in distribution equipment investment were made possible by selection of this General Electric 2500 hp synchronous motor for a municipal pumping station.

G-E Synchronous Motors

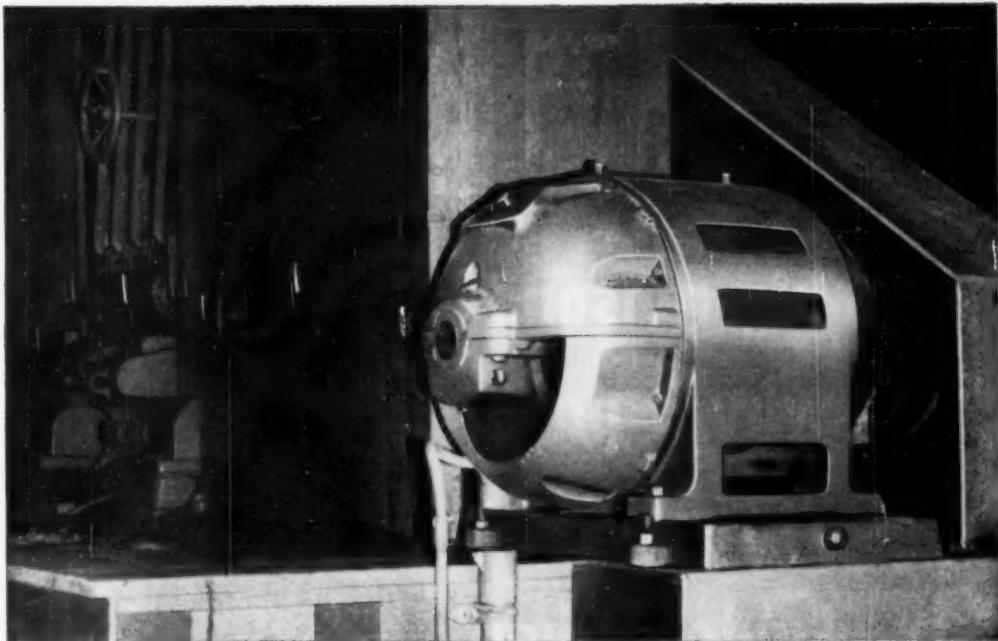


To meet the tough starting requirements of a ball mill, a mining company chose this G-E high-torque synchronous motor rated at 600 hp. Initial cost was low and the motor has given 20 years of dependable service.



Lower first cost of G-E synchronous motors is shown above. For applications in the white area, synchronous motors cost less than any other kind of motor. Calculations below show power savings on a typical 1000 hp, 514 rpm motor.

Gain in efficiency over other types of motors of same rating	2.2%
Hourly saving at power rate of \$0.01 per/kwh	\$0.184
Yearly saving (assuming constant operation)	\$1600.00



Lower operating cost is the rule when General Electric Tri-Clad[®] synchronous motors are used with equipment such as this horizontal band re-saw, operating almost continuously at heavy loads.

Offer Double Savings

Lower First Costs, Lower Operating Costs Can Be Realized on Large, Constant- Speed Applications in Many Industries

Before you select a drive for a large equipment providing heavy and continuous service, be sure to investigate the economics of General Electric synchronous motors. On many applications such as pumps, compressors, fans, etc., outstanding savings are available.

LOWER FIRST COSTS

In most ratings where horsepower is equal to or greater than speed, the price tag on a synchronous motor with exciter and control is less than that of any other a-c motor with its control.

And, because a synchronous motor improves plant power factor, initial investment in distribution equipment frequently can be reduced. (The load which any new or expanded power system will carry is proportional to the plant's power factor.)

LOWER OPERATING COSTS

A synchronous motor usually has a higher full-load

efficiency than any other type of motor, produces more work per dollar's worth of power consumed. Where loads are heavy and continuous, an advantage of from 0.5 to 3.0% in efficiency pays off.

Engineers with many years of field experience will tailor G-E synchronous motors and control to your job. Call in your General Electric representative—he'll be glad to discuss your particular application. And for more information on G-E synchronous motors, write for bulletins GEA-5332 (low-speed) or GEA-5426 (high-speed) to Section 770-26, General Electric Company, Schenectady 5, N. Y.

BE SURE TO SPECIFY G-E SYNCHRONOUS MOTORS



The result of more than 55 years experience in development, manufacture, and successful application. General Electric's line of synchronous motors is available in low speed and high speed types, engine-type and Tri-Clad[®] construction.

Numerous exclusive design and construction features promote long, dependable service. Get the full details!

*Reg. trademark U.S. Pat. Off.

GENERAL ELECTRIC



770-26

**Check the three
big reasons
why it pays
to specify
Eagle-Picher
Insulation:**

1.

2.

3.



Eagle-Picher "66" Insulating Cement—

All-purpose, rust-inhibitive, super-adhesive insulating cement. Great coverage, extreme thermal efficiency with "Springy Ball" pellets which won't collapse after application. Easy trowel application over all kinds of surfaces. Efficient up to 1800 F... reclaimable where temperatures do not exceed 1200 F.



THE EAGLE-PICHER

Cost-cutting insulations of top thermal efficiency



Insulating Cements



Fireproofing Cements



Supertemp Block



Insulseal



Blankets

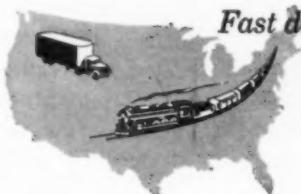


Stalastic



Dependable contractors, trained to strict factory standards

You can count on Eagle-Picher authorized contractors for uniformly high caliber service. Their qualifications provide assurance of a good job *every time* . . . efficient application of the Eagle-Picher insulation that best fits your needs.



Fast delivery from strategically located distribution points

The Eagle-Picher insulation line is stocked by distributors and authorized contractors coast to coast. The one nearest you will be happy to recommend insulating materials that give your equipment highest thermal efficiency . . . reduce fuel costs . . . help provide precise temperature control.

Eagle-Picher Supertemp Blocks—

A real insulating block—not a refractory! Unequalled for insulating quality. Weighs approximately 16 lbs. per cu. ft. Cuts easily with knife or saw . . . fits snugly over contoured surfaces. Monolithic structure . . . high refractory value. Withstands temperatures up to 1700 F. All standard sizes, from 3" x 18" to 12" x 36" . . . in thicknesses from 1" to 4".



Eagle-Picher Mineral Wool Blankets—

Made under factory supervision, these blankets fill your needs for fast, convenient insulating of flat or curved surfaces on larger types of heated equipment. The wool is felted and secured by flexible metal fabric . . . possesses outstanding physical and chemical stability for maximum resistance to water, steam, corrosive fumes and vibration.

COMPANY

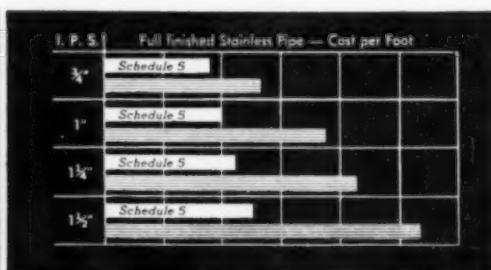


General offices: Cincinnati (1), Ohio

Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

how Carpenter is helping industry get more stainless pipe

—even today, when it's tough to get!



Comparison of costs with Schedule 40 shows savings of 10% to 45% with Schedule 5. Additional savings on costs for valves, fittings, etc. are also possible.

What Carpenter Schedule 5 Pipe Is—

Its LIGHT WALL gives *more feet of pipe* for every pound of Stainless Steel. Cost is 40% to 50% lower. Larger I.D. increases flow area and permits use of a smaller pipe size.

You now have a way to help us improve the availability of Stainless Pipe for essential uses. And you can do it at a terrific saving in your costs.

You can hook up *Schedule 5 Pipe* with existing lines of tubing or heavier wall pipe, Schedules 10 and 40.

For most jobs Carpenter *Schedule 5 Stainless Pipe* handles the working pressures with a good margin of safety. Any working pressure up to 150 psi is handled by this pipe. In pipe sizes under 1 1/2", higher pressures are frequently used.

More Stainless Pipe for essential uses is possible, even under today's conditions. To get the full story, call your nearest Carpenter Stainless Tubing Distributor. Or, write for a copy of the new "*Schedule 5 Data Sheets*". We will be glad to send you a set.



THE CARPENTER STEEL COMPANY
Alloy Tube Division, Union, N.J.

Export Department: Carpenter Steel Co., Reading, Pa.—"CARSTEELCO"

Carpenter

STAINLESS TUBING & PIPE



guaranteed on every shipment

LADISH

Controlled Quality

PIPE FITTINGS

reduce piping
assembly time

Makeup goes smoother...with less chance for delay...on those piping systems where Ladish fittings are installed. Ladish Controlled Quality makes the difference. By exacting controls over materials and manufacturing processes...Controlled Quality assures uniform weldability through metallurgical integrity, fast assembly through dimensional accuracy and provides a real assurance of ultimate operating economy and complete dependability...reasons why it pays to specify LADISH.



TO MARK PROGRESS



THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

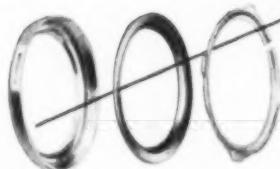
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DEPENDABLE!

DODGE SC
BALL BEARING
PILLOW BLOCK



EVEN AT LOW SPEEDS
THIS SEAL *PERFORMS!*

It's the famous Dodge metallic-backed neoprene seal that has proved itself in thousands of installations. It stays put. It can't blow. It keeps lubricant in—dust and dirt out—even at low speeds.

The SC Ball Bearing Pillow Block for small shafts and moderate loads, is a precision-built unit—a member of the famous Dodge 30,000-hour line. Modern styling . . . rugged one-piece semi-steel housing . . . long inner race . . . radial and thrust load capacity . . . fully self-aligning. Available from distributors' stocks in shaft sizes from $\frac{3}{4}$ " to $2\frac{7}{16}$ ". Write for special bulletin giving complete specifications.

DODGE MANUFACTURING CORPORATION
200 UNION STREET, MISHAWAKA, INDIANA

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new cost-saving methods. Look for his name under "Power Transmission Equipment" in your classified phone book.



SEALED LIFE V BELTS AND TAPER LOCK SHEAVES



DODGE TIMKEN PILLOW BLOCKS

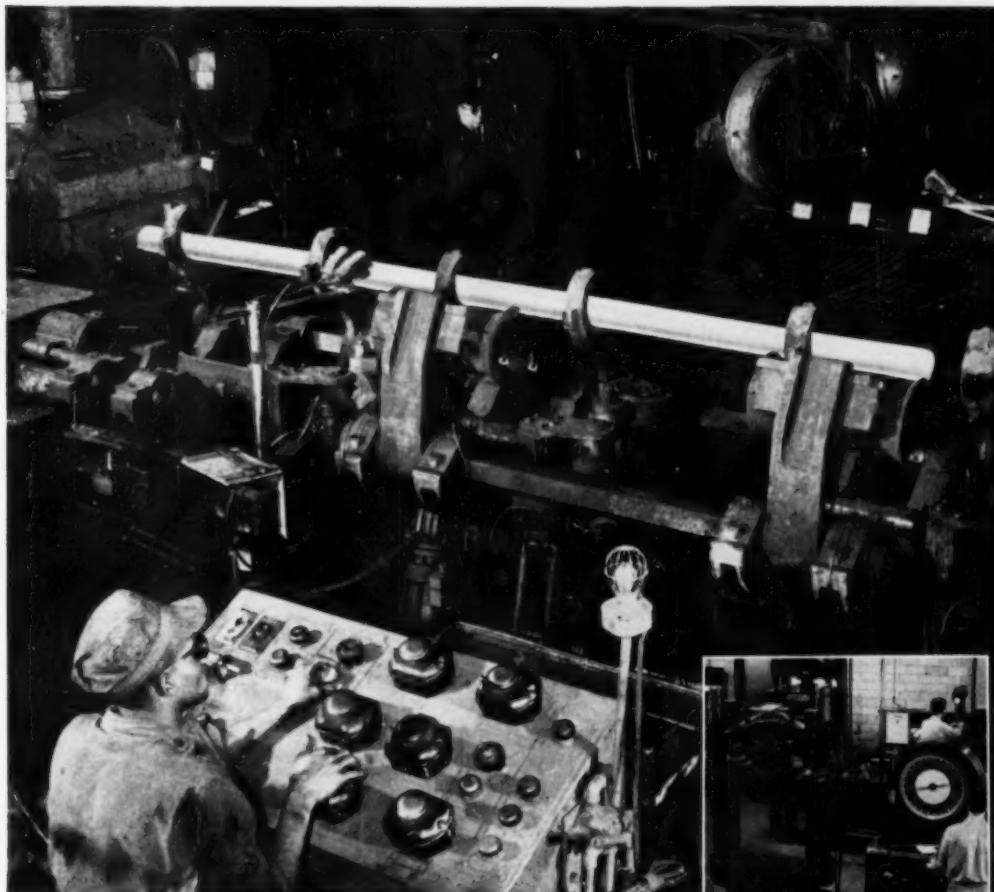


ROLLING GRIP AND DIAMOND D FRICTION CLUTCHES

NAME PLATES

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY,
CHICAGO THRIFT-ETCHING CORPORATION, 1555 SHEFFIELD AVENUE, CHICAGO 22, ILLINOIS

Specify GLOBE for the finest steel tubes



Specialized research, engineering and production assure uniform high-quality STEEL TUBES

AT Globe, specialization is the keynote. Men, machines, and raw materials are all tailored to fit the Globe *specialized* process. Precision checks — and rechecks — at every stage of production insure Globe Tubes that meet *your* exacting specifications.

Be sure! Specify dependable, high-quality Globe Steel Tubes and be certain of getting the finest tubes available. Write for the General Catalog and become acquainted with Globe *specialized* process.

GLOBE STEEL TUBES CO., Milwaukee 46, Wisconsin

Chicago • Cleveland • Detroit • New York • Houston • St. Louis
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CHEMICAL ENGINEERING—May 1952



Globe's Physical Testing Laboratory — one of the seven different research and testing labs in Globe's House of Science.

GLOBE STEEL TUBES ARE AVAILABLE IN:

- Stainless Steels — Globe seamless •
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- Standard and Special Analysis Steels •
- Mechanical and Pressure Tubing



WITCO CHEMICAL COMPANY

protects its products and its customers



-with
**Tri-Sure Closures
on every drum**

The Witco Chemical Company, of Chicago, has built a national reputation for the purity of its Paint Driers, Butyl Stearate, Plasticizers and other chemicals. And this purity is protected from plant to purchaser—safeguarded from leakage and contamination—because every Witco drum is sealed with *Tri-Sure Closures**.

Throughout the petroleum and chemical industries, company after company is offering proof after proof that *it pays to protect every product shipped in drums with Tri-Sure Closures*. There is no substitute for the Tri-Sure Flange, Plug and Seal—just as surely as there is no substitute for complete security from leakage, pilferage and contamination.

By specifying "Tri-Sure Closures" on your drum orders, you protect the quality of your product . . . enhance the prestige of your company . . . preserve the good will of your customers.

*The "Tri-Sure" Trademark is a mark of reliability backed by 29 years serving industry. It tells your customers that genuine Tri-Sure Flanges (inserted with genuine Tri-Sure dies), Plugs and Seals have been used.

AMERICAN FLANGE & MANUFACTURING CO. INC.
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Tri-Sure Products Limited
St. Catharines, Ontario, Canada

Tri-Sure
Reg. U. S. Pat. Off.
CLOSURES



This large industrial power plant moves 200 tons of coal per hour from track dump hoppers through storage silos to bunkers on Link-Belt Conveyors.

Rely on one source... one responsibility for the best in belt conveyors

LINK-BELT engineering experience plus quality components combine to cut handling costs

WETHER you must move a few tons a day or several thousand tons per hour . . . whether the haul is measured in feet or miles—you'll find the answer in belt conveyors at Link-Belt.

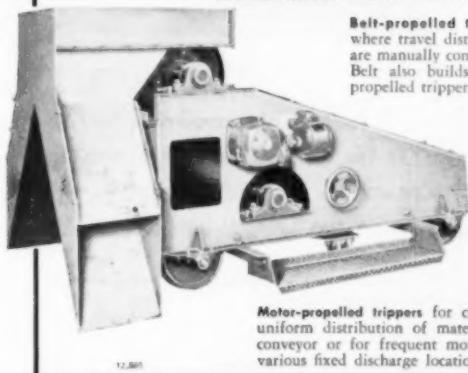
Here's a nation-wide engineering organization that will follow through from start to finish—the designing, manufacturing, erecting of conveying equipment. And nowhere can you match Link-Belt's combination of vast application experience . . . complete line of quality components . . . expert coordination of related equipment.

Get all the facts from the Link-Belt office near you. Link-Belt engineers are glad to work with you and your consultants—help you get the finest in belt conveyors.

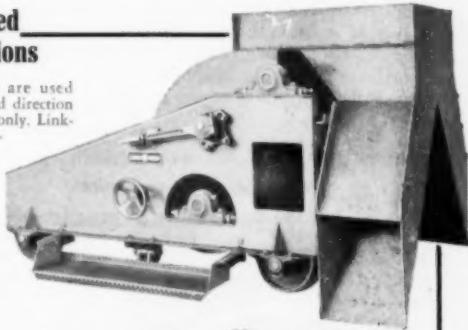
LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities.

LINK-BELT Trippers offer controlled distribution under all conditions

Belt-propelled trippers are used where travel distance and direction are manually controlled only. Link-Belt also builds winch-propelled trippers.



Motor-propelled trippers for continuous, uniform distribution of material along conveyor or for frequent movement to various fixed discharge locations.



LINK-BELT
BELT CONVEYOR EQUIPMENT

FACTS about ETHANOLAMINES

The unique characteristics of the ethanolamines have led to their large volume use in varied industries. From dry ice to sulfur, from cosmetics to detergents, the mild alkalinity and high water solubilizing power of the ethanolamines are serving both industry and the household. To assist you in realizing full value from these basic materials, Dow offers you the following information: For example, the ethanolamines can be used to recover hydrogen sulfide which can be converted to elemental sulfur. Also, you can control sulfur fumes with resulting lower maintenance costs from reduced corrosion. And, by preventing atmospheric contamination, your industrial standing in the community will be greatly enhanced. Many other uses can be developed for the ethanolamines in detergents, and cleaning and polishing compounds.

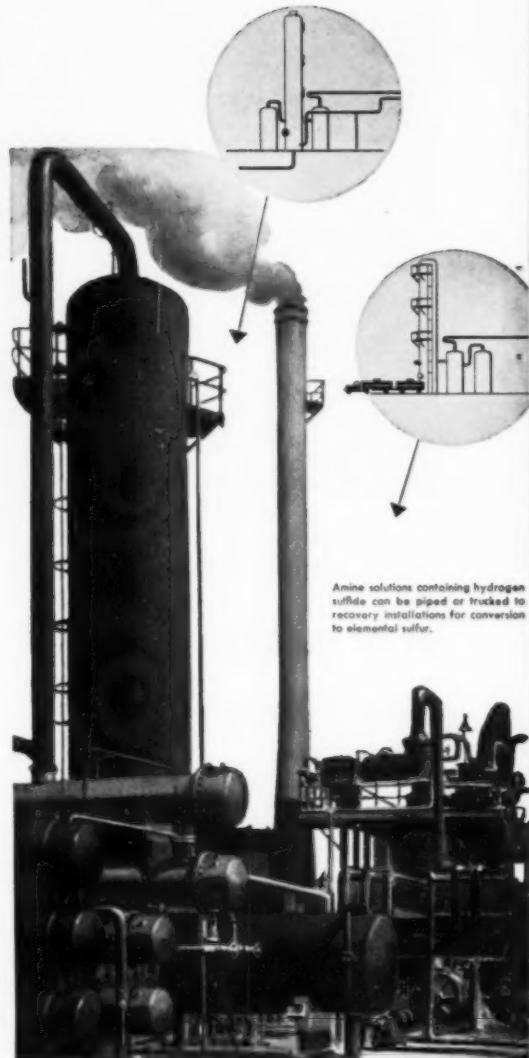
Despite today's shortages, Dow is interested at all times in helping you use the ethanolamines to best advantage in your present operations or in experimental work for future uses. For more information and technical assistance, write Dow using coupon at right.

Properties of Ethanolamines

	Monooethanol-amine	Diethanol-amine	Triethanol-amine
Molecular Weight.....	61.1	105.1	149.1
Boiling Point (760 mm.Hg), °F.	338.9	516.4	680.0
Freezing Point, °F.....	50.0	81.7	87.6
Specific Gravity (77°77°F)...	1.015	1.093*	1.120
Refractive Index (77°F).....	1.453	1.475	1.483
Flash Point, °F.....	185	285	—
Fire Point, °F.....	190	330	—
Heat of Vaporization, cal./gm.	206.5	128.2	60.1
Heat of Fusion, cal./mole.....	3915	5351	3200
*at 80/77°F.			

Solubility of Ethanolamines (at 77°F.)

	Monooethanol-amine	Diethanol-amine	Triethanol-amine
Acetone.....	•	•	•
Benzene.....	sl. sol.	sl. sol.	sl. sol.
Ether.....	sl. sol.	sl. sol.	sl. sol.
VMP Naphtha.....	sl. sol.	sl. sol.	sl. sol.
Methanol.....	•	•	•
Water.....	•	•	•



Amine solutions containing hydrogen sulfide can be piped or trucked to recovery installations for conversion to elemental sulfur.

This is one of a series of Dow advertisements you may wish to keep on file for reference and information. Write Dow for reprints.

USES OF ETHANOLAMINES

gas treatment



Monoethanolamine is used in removing carbon dioxide and hydrogen sulfide from gas streams. Then, the hydrogen sulfide may be selectively burned to produce sulfur.

When methane is burned to produce carbon monoxide and water in the manufacture of methanol, a certain amount of carbon dioxide is produced. This carbon dioxide, which would interfere with later operations, is removed with monoethanolamine.

Methane is scrubbed with monoethanolamine prior to making carbon black. This scrubbing removes any hydrogen sulfide which would subsequently be converted to sulfur and contaminate the carbon black.

Diethanolamine is used in much the same manner as previously described for monoethanolamine. However, diethanolamine may be used in cracking gases and coal or oil gases which contain carbonyl sulfide that would react with monoethanolamine.

surface active agents



Monoethanolamine and triethanolamine may be reacted with sulfonated alkyls or fatty acids to produce detergents, soaps, shampoos and various cleaning compounds. To this date, the largest single use is in the production of a moderate duty household detergent.

Diethanolamine is used extensively in the production of lubricants for the textile industry. These lubricants can be easily removed by the use of a detergent. Also, diethanolamine is used in detergents, soaps and cleaning compounds.

cleaning and polishing compounds



Triethanolamine is used in the manufacture of cleaners and polishes for metals, wood, leather, floors, and

furniture. Triethanolamine soaps act as emulsifiers and dispersing agents in these applications. Triethanolamine is also used in automobile polishing, cleaning and degreasing compounds. It is used in emulsion stabilizers and dispersing agent for waxes and industrial lubricants.

miscellaneous uses



Monoethanolamine is reacted with other chemicals to produce an accelerator which has greatly reduced the time required for producing penicillin. Monoethanolamine is also used in a variety of other products such as wax removal compounds.

Diethanolamine is used as an emulsifier and dispersing agent in various agricultural chemicals, cosmetics and pharmaceuticals.

PRECAUTIONARY MEASURES

The ethanolamines do not present an appreciable fire hazard. Monoethanolamine has the lowest flash point of the three (185°F.) and should not normally present a hazard except in cases of large leaks or spills.

The ethanolamines present no unusual toxicity hazards. Monoethanolamine may cause skin irritation in concentrations greater than 1% and contact should be avoided as much as possible. Diethanolamine is markedly irritating in concentrations greater than 10%. Triethanolamine is not seriously irritating if diluted and will probably cause no serious difficulty unless prolonged or repeated exposures are encountered.

Strict precautions should be observed whenever there is a possibility of eye contamination with an ethanolamine. All persons should wear face shields, goggles with side shields, or the equivalent. Suitable facilities for washing the eyes should be readily available. If contaminated, the eyes should be washed with large amounts of flowing water and medical aid should be summoned.

If an ethanolamine is spilled on the person, all contaminated clothing should be removed and not worn again until decontaminated. The exposed area should be washed with plenty of flowing water and medical aid should be summoned for victims of extensive or prolonged exposure.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

WRITE DOW FOR INFORMATION AND TECHNICAL ASSISTANCE.

The Dow Chemical Company, Dept. OC-40, A
Midland, Michigan

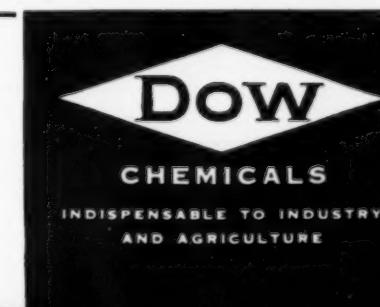
Please send _____ reprints of this advertisement.

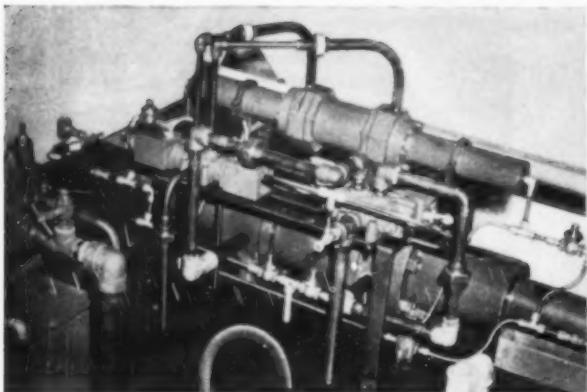
Name _____ Title _____

Company _____

Address _____

City _____ State _____





NICKEL ALLOYED STEELS, heat treated to high strength values, provide parts of extreme toughness and reliability for Harwood intensifiers, such as this typical installation in a glass company's plant.



TYPE 316 STAINLESS IS UTILIZED in Foxboro indicators and recorders such as these shown in use with a Harwood intensifier.

NICKEL ALLOYS HELP MAKE PRESSURES UP TO 2000 ATMOSPHERES COMMERCIALLY PRACTICAL

New equipment and processes now being used to explore pressures
up to 10,000 ATMOSPHERES

Heretofore, the highest pressure commonly used industrially has been for ammonia synthesis at 1000 atmospheres...

Now, however, pressures of at least 2000 atmospheres (30,000 p.s.i.) already serve production processes, and apparatus capable of delivering pressures up to 200,000 p.s.i. has been designed by the Harwood Engineering Company of Walpole, Mass.

To secure essential stamina in high pressure heads of intensifiers, as well as in reactor vessels, valves and fittings, Harwood engineers fabricate these parts from nickel alloyed steels. The types used, include S.A.E. 4340 (nickel-chromium-molybdenum), S.A.E. 3250 (1.75% nickel-chromium) and S.A.E. 3450 (2% nickel-chromium). They are heat treated to very high strength, with a double tempering treatment after liquid-quenching.

Developed for use in conjunction with these new high pressure units are instruments for measurement and control... produced by The Foxboro Company of Foxboro, Mass.

Foxboro utilizes a nickel-alloyed stainless steel, Type 316, containing 17% chromium, 12% nickel and 3%

molybdenum, for heavy duty helical elements that determine pressures up to 80,000 p.s.i. Results in service prove the correctness of choosing Type 316, since it resists corrosion from a wide variety of chemicals, and combines good spring qualities with high yield point after suitable cold working.

Harwood, also, uses Type 316... sometimes to line composite tubes, and sometimes as solid tubing to handle pressures up to 200,000 p.s.i.

Thus, nickel-containing alloys play an important role in developments which may open new industrial frontiers.

At present, the bulk of nickel produced is being diverted to defense. Through application to appropriate authorities, nickel is obtainable for the production of engineering alloy steels for many end uses in defense and defense supporting industries. Counsel and data on alloys containing nickel, for your present or future projects, may be had for the asking. We invite your inquiries.



THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

New Bulletin about the **HAGAN** **RATIO TOTALIZER**

This simple and versatile control mechanism, designed by Hagan Engineers, has wide application in pneumatic control circuits which include simple or complicated computing functions.

This new bulletin about the Hagan Ratio Totalizer and what it does, is yours for the asking.



*for your copy,
clip the coupon*

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTOR[®] FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

**Hagan Corporation
Hagan Building
Pittsburgh 30, Pennsylvania**

Please send me a copy of the new bulletin about the Hagan Ratio Totalizer

Name.....

Position.....

Company.....

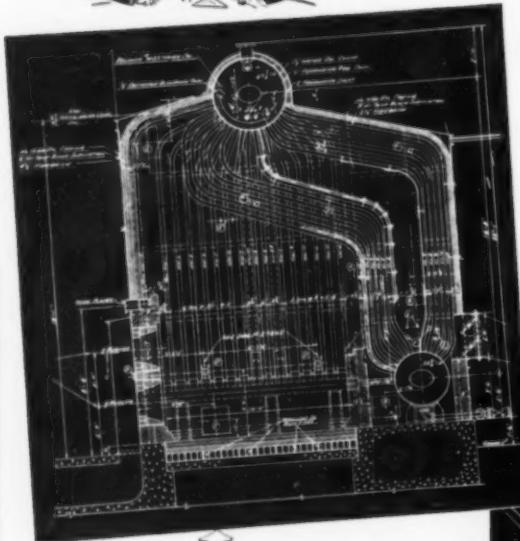
Street and Number.....

City..... Zone..... State.....

GT-5



Industry Approved



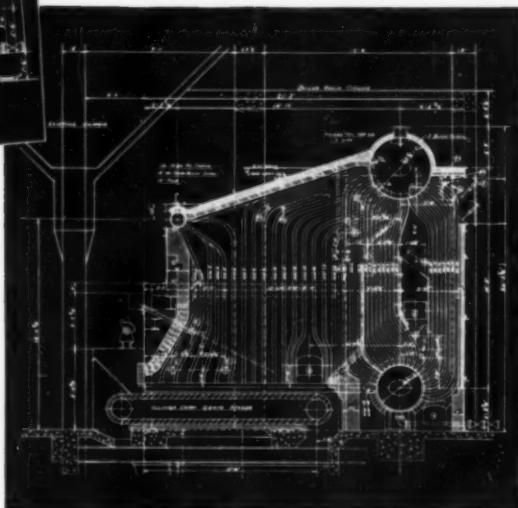
CLASS VF
A 22,000 pounds steam per hour unit installed at
Indiana Farm Bureau Refinery, Mt. Vernon, Ind.

CLASS VS
The Southgate Hotel, Louisville, Ky. is served by
this 30,000 pounds steam per hour boiler.

A wide variety of industrial plants and other users of steam for power, processing, or heating have found these efficient Vogt Two-Drum Type Boilers to be the answer to their diverse steam generating requirements.

Class VF units provide maximum capacity in limited floor space and head room, while Class VS is best adapted to installations not having such restrictions. Each has a large furnace volume and a high ratio of radiant heating surface. The furnace design assures proper combustion of fuels fired in suspension or with various type of stokers.

A bulletin with general information and showing typical installations is available on request.



✓ Typical Users...

FOOD PROCESSING PLANTS

DISTILLERIES • HOTELS

HOSPITALS • CHEMICAL PLANTS

PETROLEUM REFINERIES

HENRY VOGT MACHINE CO., Louisville 10, Kentucky

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

Stainless and High Alloy Castings

**for severe
chemical service**

Corrosion, heat and abrasion are *not* serious problems...*for the chemical plant that uses ESCO cast stainless and high alloy equipment.*

Into these castings goes a combination of design and metallurgical experience, supported by complete facilities for casting and heat treatment. Non-destructive testing, including X-ray, gamma ray and Zy glo are used frequently to check the structure of castings and assure uniformly high quality.

Resulting equipment gives prolonged service under adverse operating conditions with a minimum of production interruptions.

ESCO

Stainless and
High Alloy Steels

ELECTRIC STEEL FOUNDRY

2143 N. W. 25th Avenue, Portland 10, Oregon

Sales Offices and Warehouses:

CHICAGO, ILLINOIS

EUGENE, OREGON

HONOLULU, T. H.

HOUSTON, TEXAS

SPOKANE, WASHINGTON

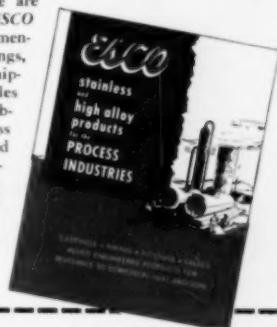
IN CANADA — ESCO LIMITED, VANCOUVER, B. C.



Special Stainless Valve Stand Casting

A NEW CATALOG FOR YOU!

Let us give you detailed facts of ESCO service. These are contained in our new catalog "ESCO Stainless and High Alloy Products". Included here are technical descriptions of ESCO alloys; illustrations and dimensions of ESCO pipe, fittings, valves and processing equipment; frequently used tables of weights of bars and tubing; temperature, hardness and metric conversions; and data on corrosion resistance of principal ESCO alloys to commonly used corrosive media. . . Get your copy from nearest ESCO office, or fill in and mail the coupon.



ELECTRIC STEEL FOUNDRY

2143 N. W. 25th Avenue, Portland 10, Oregon

Please send me your new catalog, "ESCO Stainless and High Alloy Products".

Name _____

Company _____

Address _____

City _____

Zone _____ State _____

FACT

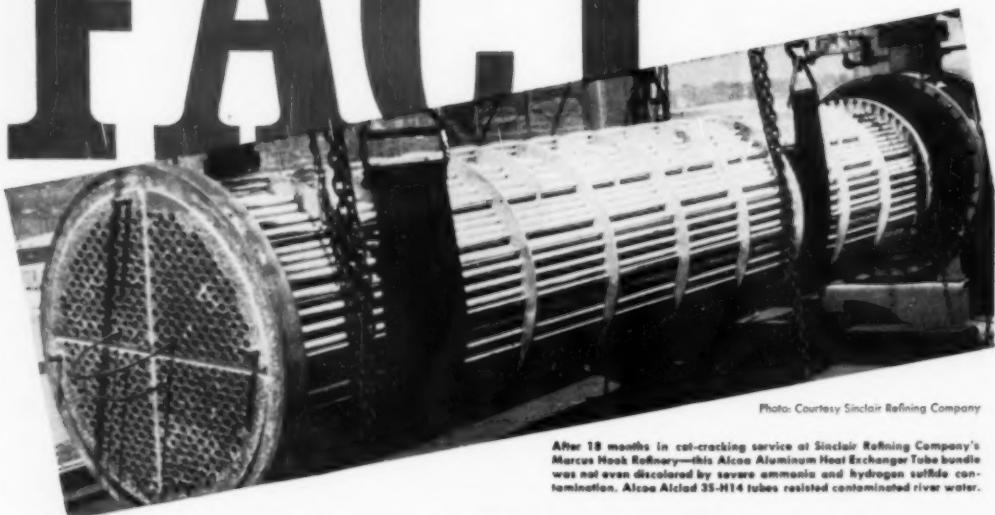


Photo: Courtesy Sinclair Refining Company

After 18 months in cat-cracking service at Sinclair Refining Company's Marcus Hook Refinery—this Alcoa Aluminum Heat Exchanger Tube bundle was not even discolored by severe ammonia and hydrogen sulfide contamination. Alcoa Alclad 35-H14 tubes resisted contaminated river water.

ALCOA

knows most about the use and application of aluminum heat exchanger tubes

Alcoa pioneered the use of aluminum in heat exchanger tubes 43 years ago. Although their sale today is limited by government regulation, you will want to start planning with a copy of the booklet, "Alcoa Aluminum Heat Exchanger Tubes." Write:

ALUMINUM COMPANY OF AMERICA • 1860E Gulf Building, Pittsburgh 19, Pa.



OVER 6-MILLION FEET OF ALCOA TUBES ARE IN USE FOR APPLICATIONS LIKE THESE . . .

PETROLEUM

Condensers handling hydrocarbon fractions from such processes as Thermal and Catalytic cracking, reforming, polymerizing, etc.
Vapor recovery condensers
Lube oil coolers
Natural gas compressor after-coolers
Recompressor aftercoolers
Hydrogen sulfide gas coolers
Furfural condensers and heat exchangers

PROPYLENE GLYCOL

Wax sweepers
Lean oil-rich oil exchangers
Amino solution coolers
Glycol-amine heat exchangers and reboilers
Jacket water coolers

CHEMICAL

Butanol
Ethanol
Ethylene Glycol
Glycerin

Hydrocarbons

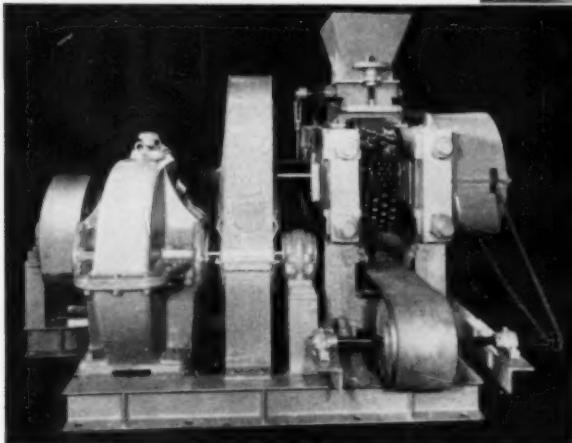
Isopropanol
Methanol
Phenol
Propylene Glycol
Acetaldehyde
Formaldehyde
Furfural
Heptaldehyde
Acetic acid
Stearic, Palmitic, Oleic acids
Butyric acid
Naphtha

Fatty Acids

Ricinoleic acid
Acetanilide
Ammonia
Hydrogen Cyanide
Nitric acid (concentrated)
Pyridine
Hydrogen Sulfide
Benzene
Dichlorobenzene
Gelatin
Hydrogen Peroxide
Turpentine
Xylene

Use Alcoa Alclad 35-H14 Heat Exchanger Tubes with fresh, brackish and salt-cooling waters

At right: Vulcan laboratory for briquetting research. Equipped for chemical and physical tests. Illustration shows technician making sample briquette under measured hydraulic pressure.



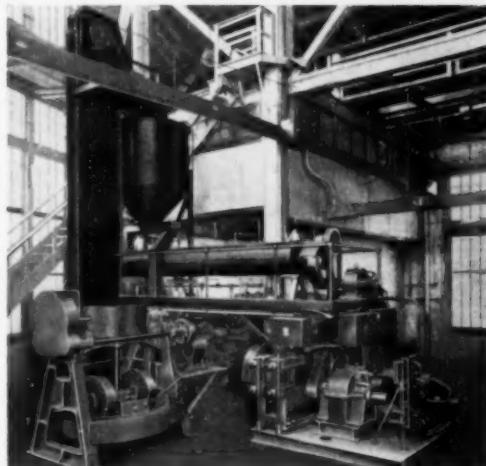
At left: Self-contained unit for briquetting high-carbon ferro-chrome ore. Comprises motor, speed-reducing gears, feeding and discharge mechanisms, in addition to the heat-treated alloy-steel briquetting rolls.

BRIQUETTING MAY BE THE BEST ANSWER TO YOUR PROBLEM

For many years the Vulcan Iron Works has been designing and manufacturing heavy-duty briquetting equipment—thereby helping to solve many problems relating to the beneficiation and successful utilization of materials that were either not usable at all in their original form or could not be utilized efficiently. Materials treated range from chemicals to various types of metalliferous fines—often in combination with coal or coke and various types of binding material.

In addition to designing and building briquetting machines to meet any specific requirement we are equally prepared to design and build all necessary equipment for grinding, mixing, heating and feeding material to the briquetting machines and for carrying away the finished briquets.

Correspondence regarding any present or prospective briquetting requirement is cordially invited and arrangements will be made, if desired, for conducting either laboratory or pilot-plant tests and research.



Pilot briquetting plant in which trial runs can be conducted on a sufficiently extensive scale to determine proper commercial procedure and approximate production cost. Provided with facilities for grinding, mixing and feeding materials to the press.

VULCAN IRON WORKS

Established 1849

Main Office and Works WILKES-BARRE, PA., New York Office 50 Church

Rotary Kilns, Coolers and Dryers
Rotary Retorts, Calciners, Etc.
Improved Vertical Lime Kilns
Automatic Quick-Lime Hydrators

Double-Roll Briquetting Machines
Open-Hearth Steel Castings
Steel-Plate Fabrication
Shaking-Chute and Chain Conveyors

Heavy-Duty Electric Hoists
Self-Contained Electric Hoists
Scraper-Loading Hoists
Cast-Steel Sheaves and Gears

Steam Locomotives
Diesel and Gasoline Locomotives
Diesel-Electric Locomotives
Electric Locomotives and Larrys



New pumpless rectifiers in ratings of 750 kw and above, made possible by G-E semi-permanently sealed tanks, minimize vacuum losses, provide high service reliability. Maintenance is reduced because vacuum pumps are eliminated, and moving parts are at a minimum.



Outside the building at Oldbury's Niagara Falls plant and throat-connected to the rectifier equipment inside, is this G-E 12,000-volt step-down transformer. Induction voltage regulator at left, with taps for load ratio control, provides smooth, stepless voltage adjustment from 300 to 375 volts.

First pumpless rectifier in electro-chemical industry cuts d-c power-supply costs!

New G-E power-conversion package in larger ratings eliminates vacuum-pumping equipment, saves on installation, operation and maintenance



**D-C POWER
SYSTEMS**

for electro-chemical plants

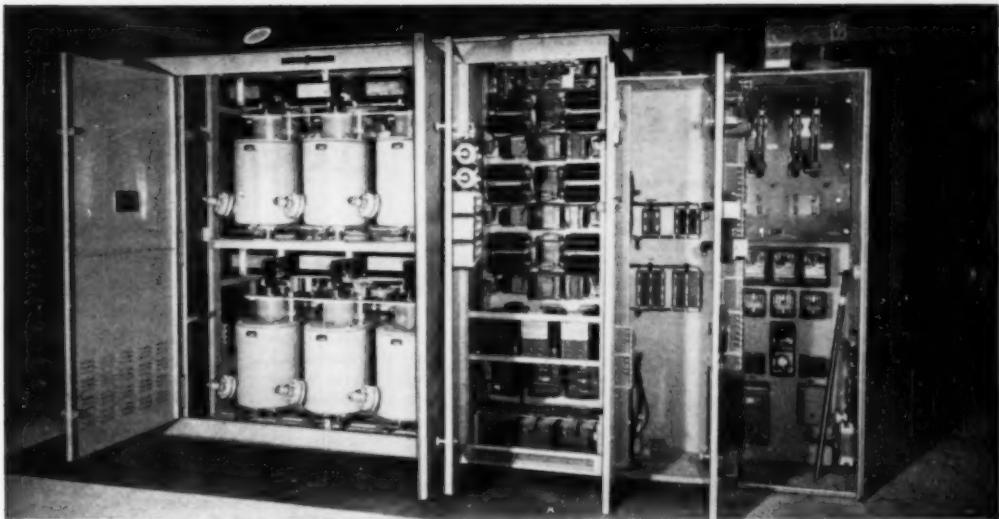
NEW G-E MOTOR SELECTION AND APPLICATION COURSE can help train your chemical plant electrical personnel, increase their value to you. Find out all about this "More Power to America" program by sending for free 16-page illustrated brochure, Bulletin GED-1500.

Latest example of G-E pioneering in power rectification is this recent installation—at Oldbury Electro-Chemical Company's Niagara Falls plant—of the electro-chemical industry's first pumpless mercury-arc rectifier. This new development, by eliminating vacuum pumping and combining the entire rectifier assembly in one compact, integrated unit, introduces savings like these:

Cuts installation costs—Unit is factory-wired for quick connection, needs no special foundations, and takes up less building space. *Cuts operating costs*—No vacuum pumping losses are sustained. *Cuts maintenance costs*—With a minimum of moving parts, periodic inspections are reduced. Moreover, service reliability is increased—employees are protected by the dead-front metal enclosure—and downtime is reduced because of the speed with which a spare tank can be installed if needed.

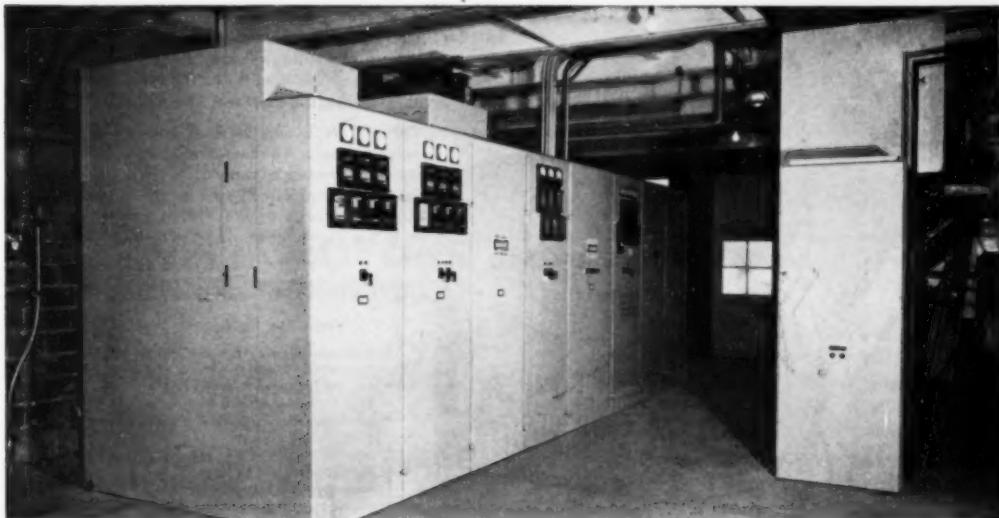
If your chemical-plant operation requires reliable, low-cost d-c power supply, investigate these new G-E pumpless rectifiers. Ask your G-E representative for more information, or send for new Bulletin GEA-5569. *General Electric Company, Schenectady 5, N. Y.*

CHEMICAL-PLANT ELECTRIFICATION



Compact and co-ordinated, G-E pumpless rectifiers fit in smaller buildings, save up to 25 per cent in building costs. Metal-enclosed assembly

includes rectifier tanks, excitation cubicle, and rectifier auxiliary control. Factory-wired, they arrive ready to connect and operate.



Completing the package at Oldbury—to provide everything needed from incoming a-c line terminals to d-c outgoing feeders—is this G-E, 500-mva metal-clad switchgear, located in the basement. It includes one feeder and an auxiliary compartment for the rectifier. Unit at right

is the draw-out cathode breaker section for protection of rectifier. Metal-enclosed for personnel protection, it pulls out easily to provide ample room for inspection.

GENERAL ELECTRIC

662-38



Square pegs
wonderfully
packaged in
round holes

If your product is normally made for civilian use . . . using the same packaging for your DO's may be putting a very square peg in a round hole. *Defense packaging needs attention!* And that's where Visqueen® film comes in! Visqueen can improve your DO packaging without extra cost; possibly even at farless cost.

Visqueen has a flexibility needed for odd shapes and sizes. It gives longer "shelf life," greater protection. Visqueen is pure, tasteless, odorless and chemically inert. Pliable at extremely low temperatures—crackproof and waterproof. *Visqueen has an unusually high uniformity of gauge.*

It's possible that Visqueen film may be available shortly for your civilian packaging, too! In that case, Visking's wide experience with film can certainly benefit you. Visqueen will be pleased to offer advice on methods of handling, packaging line layout and types of film . . . for both military and civilian packaging. Go ahead—*Call on Visqueen!*

IMPORTANT! Visqueen film is all polyethylene, but not all polyethylene is Visqueen. Visqueen is the only film produced by process of U.S. Patent No. 2461975. Only Visqueen has the benefit of research and extensive technical experience of The Visking Corporation, pioneers in the development of polyethylene film.

Visqueen Packaging Firsts!

- liquid and dry chemicals and pharmaceuticals in drums, cartons and cases.
- weather balloons for armed forces
- bags for batteries for armed forces
- packaging of small machine parts (for moisture protection)
- rubber separators (as in camelback)
- liners for multi-walled bags
- bags for pre-peeled potatoes
- sterling silver flatware and hollow ware (as tarnish resistor)
- bags for poultry

VISQUEEN*
film

... a product of THE **VISKING** CORPORATION • Preston Division, Terre Haute, Indiana

*T.M. The Visking Corporation


JOHN B. STETSON COMPANY
 PHILADELPHIA 22, PA



↑
the
STETSON

is
part
of the
man

Mr. C. C. Lucas
Howell Electric Motors
Broad Street Suburban Station
Philadelphia, Penna.

Dear Mr. Lucas:

It is not every day these days that a buyer can
express his thanks and appreciation to a vendor for prompt
compliance with scheduled delivery dates.

I want to do just that to you and, through you,
mention, also, that we are very pleased. While I am at it I wish to
workmanship and cleanliness of your motors. Because of
our own product owes its national eminence of design of your motors. Because of
feel peculiarly fitted to recognize that standard in others.
With appreciation for your individual interest
and the valuable cooperation of your factory, I remain

Yours very truly,
A. Kennedy, Jr.
A. Kennedy, Jr.
Plant Engineer

MORE PEOPLE WEAR STETSON HATS THAN ANY OTHER BRAND

AKJr/MC

HOWELL MOTORS are part of the **STETSON**



HOWELL Type K
Motor. Offers constant performance in
the presence of dirt,
dust, fumes and moisture.
Sizes from 1/2 to
50 H.P. up to 1000 R.P.M.
Either vertical or horizontal mounting.



We think you, too, will appreciate Howell's attention to your electric motor problems. Howell engineers are always ready with technical assistance on motors in the standard NEMA frame sizes or with specially designed motors if your situation requires them.

So, on the tough jobs, on every job, consult Howell — manufacturers of industrial type motors from 1/6 to 200 H.P. since 1915. Contact the Howell representative in your city or write to us direct.



HOWELL Sanitary
Motors meet the most
exacting standards of
the dairy and food industries.
They contain no pockets, cracks, or
crevices. Available for
vertical or horizontal
mounting.



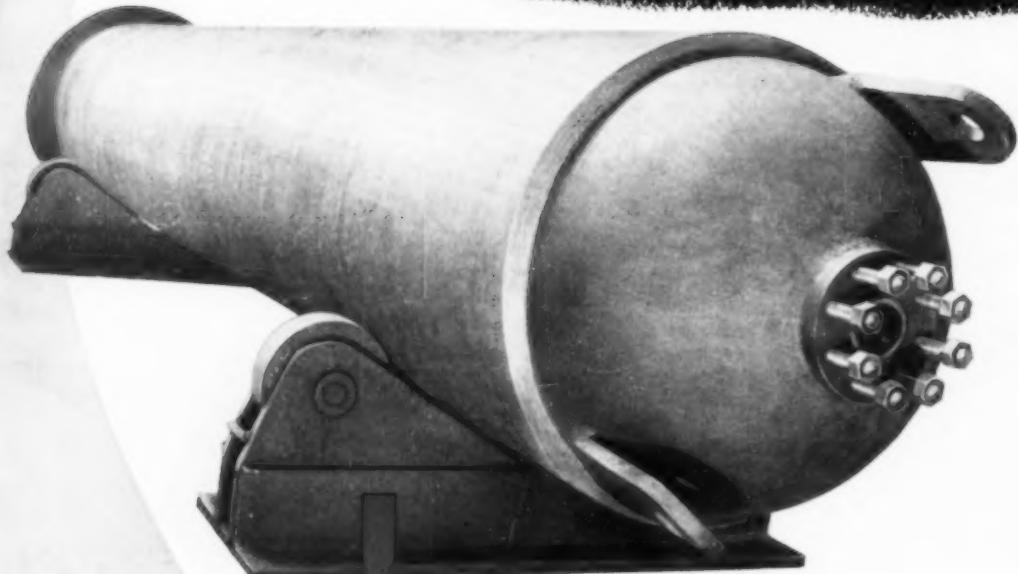
HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

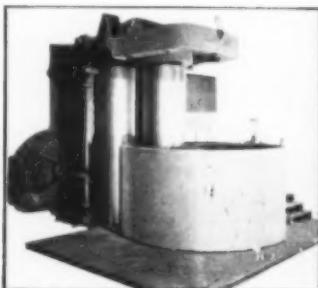
Precision-built Industrial Motors Since 1915

Banded Bottles

...for Pressure Systems



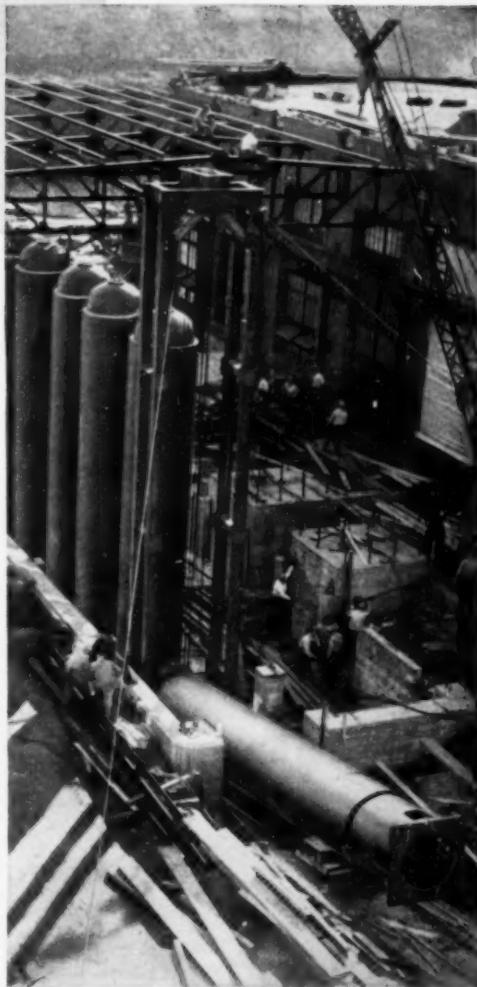
**made-to-measure
built-to-last**



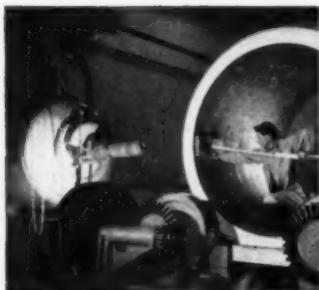
Up to 6000 psi

For pressures from 2000 to 6000 psi, B&W Banded Pressure Vessels have the advantage of withstanding higher pressures than vessels made by conventional welding construction. The inner vessel, fabricated in accordance with the ASME Code, withstands longitudinal pressure loading. A series of circumferential bands reinforces the inner shell, and enables it to withstand circumferential loading.

Uncompromising care and advanced techniques go into every B&W manufacturing step to assure the ultimate in safe and sound process equipment. Forming, machining, welding, stress-relieving—every production operation from start to finish of B&W pressure vessels—is performed on equipment specifically designed for each purpose. Much of the equipment and types of construction are original B&W developments.



Installation of B&W Accumulators, for use in connection with hydraulic presses.



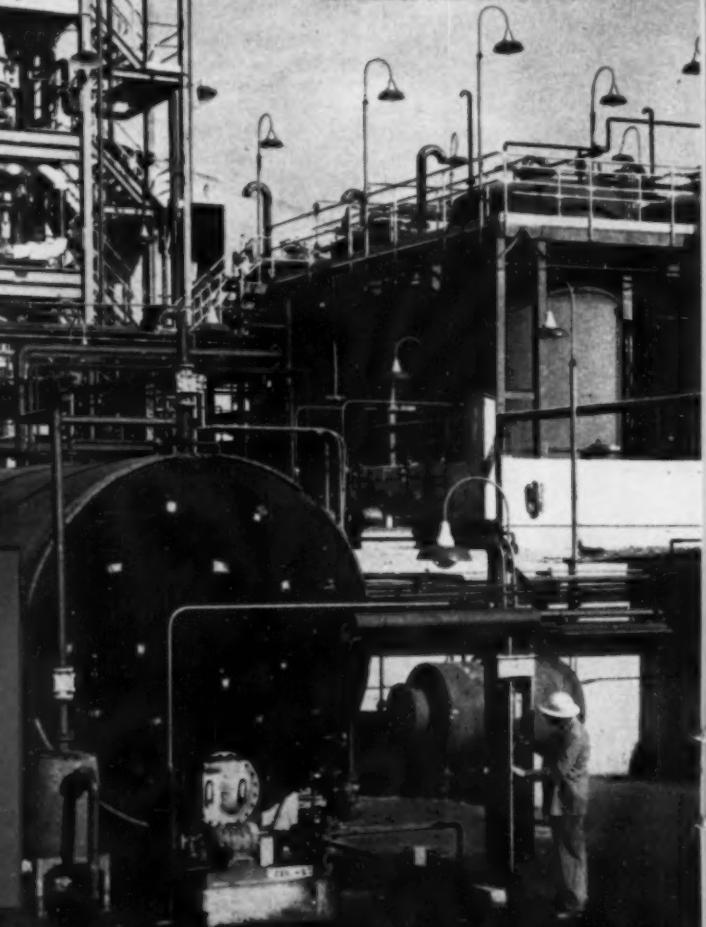
S-402 T

Building

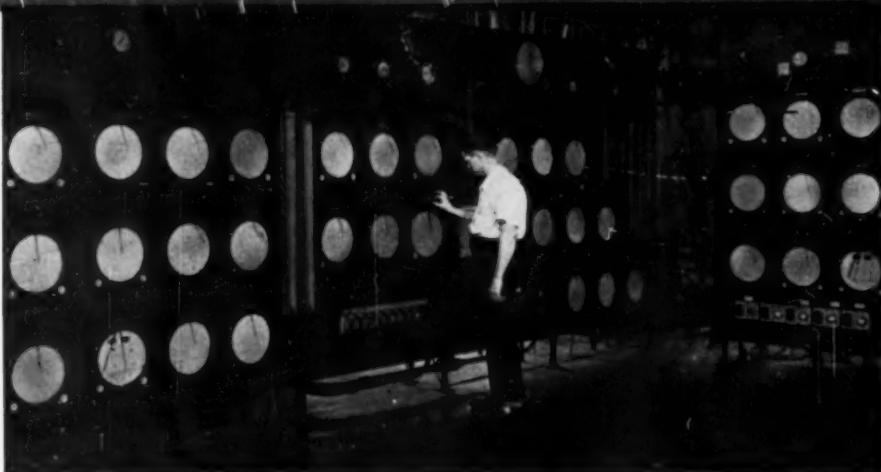
Processing Units and (at right) Brown Control Panelboard for Plexiglas production at Rohm & Haas Company, Bristol, Pa.

BROWN INSTRUMENTATION

... is patterned to the exact requirements of individual plants and processes . . . is the result of engineering and application know-how, with one responsibility from sensing elements to control valves . . . is backed by a nationwide field engineering and service organization.



new molecules . . .



with the help of Brown Advanced Instrumentation

TODAY's tremendously increased demand for synthetic resins and rubbers is being met by greatly accelerated production of vinyl type and other polymers. Keeping pace with this gigantic effort is the production of Plexiglas at the modern Rohm & Haas plant at Bristol, Pa.

Control of every significant step in this polymerization process is synchronized by efficient, coordinated Brown Instrumentation. From a centrally located panelboard, these instruments insure precise regulation of even the most complex exothermic reactions, where process variables must stay within stringent limits.

When choosing recording and controlling instruments for your vinyl polymerization process, or

any polymerization process, consider first:

- *Brown Creative Instrumentation—the know-how developed through many years of application experience in the industry.*
- *The completeness of Brown equipment—encompassing sensing elements, recorders, controllers, panelboards (both conventional and graphic), valves and accessories.*

For a detailed discussion of control requirements of your process, call in our local engineering representative . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO.,
Industrial Division, 4478 Wayne Avenue, Philadelphia 44, Penna.



- *Important Reference Data*
Write today for Composite Catalog 5000.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

THE MICROSEN BALANCE

AN UNPARALLELED ADVANCE IN THE APPLICATION OF
ELECTRONIC COMMUNICATION
TO PROCESS CONTROL

THE MICROSEN BALANCE is a compact, modified Kelvin Galvanometer structure—operates automatically on the force balance principle. It transduces mechanical motions into electrical signals and vice versa—is equally effective for the stable amplification of electrical signals.

A calibrated spring converts mechanical motion to force loading of a pivoted beam. The tuning of a high frequency oscillator coil, adjacent to the beam, detects the balance conditions of the beam and varies the current flow in the circuit accordingly. The rectified oscillator output—.5 to 5 milliamperes—serves as the transmission signal. A calibrated portion of this signal is fed back to an actuator coil, attached to the underside of the beam, which operates in a permanent magnetic field. This electrical feedback signal applies a force opposed to the mechanical input force.

Whenever the two opposing forces become unequal, equilibrium is immediately reestablished by the movement of the beam which either increases or decreases the magnitude of the output current.

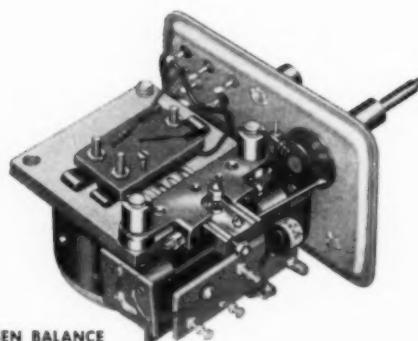
Output current value is constantly compared with the mechanical input value. Thus, the Microsen Balance insures a linear current signal proportional to the mechanical input and independent of the transmission circuit resistance, up to a maximum of 3,000 ohms.

The Microsen Balance—used in all American Electronic Instruments—instantly transmits *pressure, temperature, flow and liquid level information* to the panelboard and controller signals to the valve. It provides these advantages of electric communication:

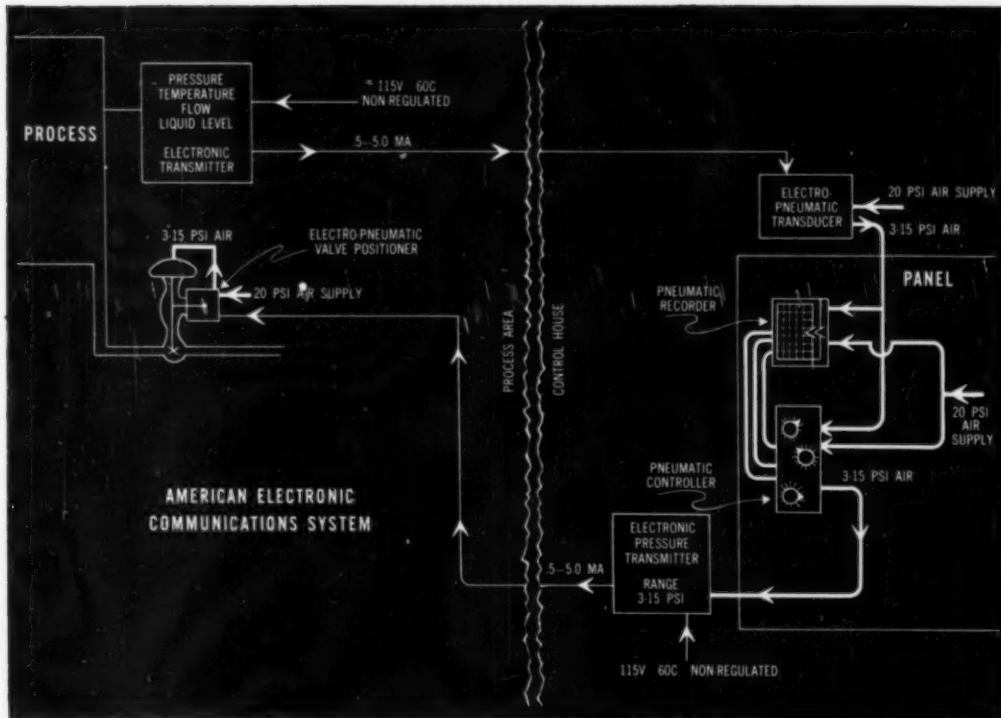
1. Virtually eliminates transmission lags by restricting the use of pneumatic lines to control boards. (The average signal delays over 500 feet of transmission line are 10 seconds for pneumatic, 5×10^{-7} seconds for electric).
2. Eliminates all distance considerations.
3. Assures superior performance in process control by high speed response. All changes are detected and corrective measures are initiated



THE MICROSEN BALANCE



AMERICAN



practically instantaneously. This type of "tight" control envisions smaller process equipment for given throughput.

4. Makes all adjustments readily accessible to one operator in the control room.
5. Eliminates freeze-ups of pneumatic lines. Climatic conditions can be completely disregarded.
6. Replaces four pneumatic lines from the panel loading station to the controller at the valve by a simple, two-wire circuit. (Pneumatic controllers must often be located near the valve in order to reduce response delays.)
7. Reduces signal line maintenance.
8. Permits the utmost flexibility through the current type signal. Any number of receiving instruments may be located in a single transmission circuit. Signals are additive for control function computation using two or more input signals.

Elements in the American Electronic Communications System are:

ELECTRONIC TRANSMITTER. Types to transmit pressure, differential pressure, temperature, flow or liquid level. Produce a .5 to 5 milliamperes current signal proportional to the magnitude of the vari-

able being measured. Constantly compare electrical output with the magnitude of the measured variables—insure accurate and linear output.

ELECTRO-PNEUMATIC TRANSDUCER. One type utilizes an electronic amplifier and may be used for very low-level signal inputs such as derived from thermocouples. Another type incorporates a mechanical or pneumatic type amplifier—is especially suited for use with the transmission signal of .5 to 5 milliamperes. Both convert electrical input to proportional pneumatic output. They provide the means for utilizing pneumatic recorders and controllers now widely used. Constantly compare the pneumatic output of 3 to 15# of air with the electrical input signal—assure linearity and accuracy.

CONTROLLERS. Pneumatically operated. Widely used with indicators and recorders of the pneumatic type. Some are built integrally with these units or as separate units in the stacked type.

ELECTRONIC PRESSURE TRANSMITTER. Converts air output from controller into an electrical signal.

ELECTRO-PNEUMATIC VALVE POSITIONER. Receives .5 to 5 milliamperes signal and compares it to the actual displacement or position of the valve stem—produces a pneumatic signal which mechanically operates the valve.

INDUSTRIAL INSTRUMENTS

A product of MANNING, MAXWELL & MOORE, INC., STRATFORD, CONNECTICUT
MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES. BUILDERS OF 'SHAW-BOX' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.





**NEW
SEGMENTAL DRIVE ASSEMBLY**

with stainless steel ball-type chain that insures free travel and perfect alignment of float; and new positive collet-type shaft clamp. Exclusive Foxboro ambient temperature compensation available in Type 28 Meters.

**NEW
PRESSURE-SEAL BEARING**

of stainless steel, with exclusive ring seal that gives unequalled freedom from friction and maintenance ... complete freedom from leaks at any working pressure. No lubrication required.

**NEW
CHECK FLOATS**

with positive-seating stainless steel ball plug. Submerged in mercury for complete protection against frosting and corrosion.

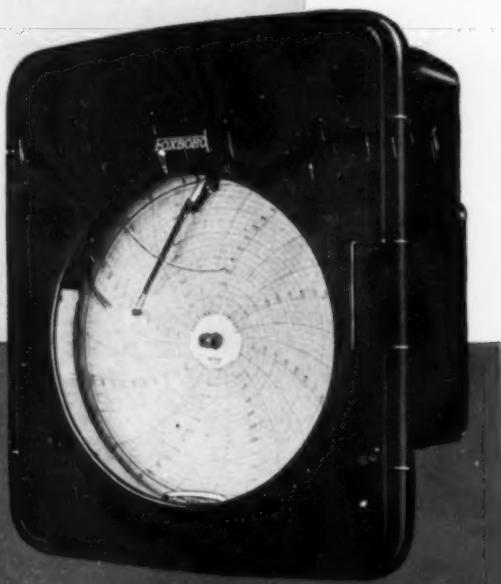
**NEW
U-BEND AND DAMPING
PLUG ASSEMBLY**

— Self-aligning, all-welded construction with union couplings that require no gaskets. Calibrated damping plug fully adjustable under pressure. Directed drain for mercury at lowest point.

**NEW
COMPACT FLOAT CHAMBER**

gives greater accessibility for easier, quicker cleaning.

New Basic Advances that Mean



METERS FOR STEAM, GAS, LIQUIDS

Specifications

	N	D	T	FAIRBANKS
	800			1", 1 1/2", 2", 3", 5", 10"
	1000			100", 100", 400"
	1500			10", 10", 30", 80", 100", 200", 300", 400", 5", 0-5", 10", 0-10", 25", 0-25", 50", 0-50"
22"	1000			100"
28"	1000			50", 100", 200", 400"
29"	150			1", 2 1/2", 5", 10"

*formed wings slumber for uniform scale flow measurement

**Bell Type

BETTER METERING!

With major improvements in every basic detail of differential meter design, the complete new line of Foxboro Flow Meters now gives, not only higher sustained accuracy, but also unprecedented ease of maintenance. It all adds up to metering performance that's farther ahead of the field than ever before!

In addition to the outstanding improvements illustrated, these new meters incorporate numerous other advanced features, including: interchangeability of all parts; large floats with long travel for added power; and location of floats in high pressure chamber to minimize ambient temperature effects.

Write for New Bulletin 460 containing detailed information on the design, construction and specifications of the new Foxboro Flow Meters . . . indicators, recorders, controllers and transmitters . . . round or rectangular cases . . . with or without integrators.

The Foxboro Company, 385 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO

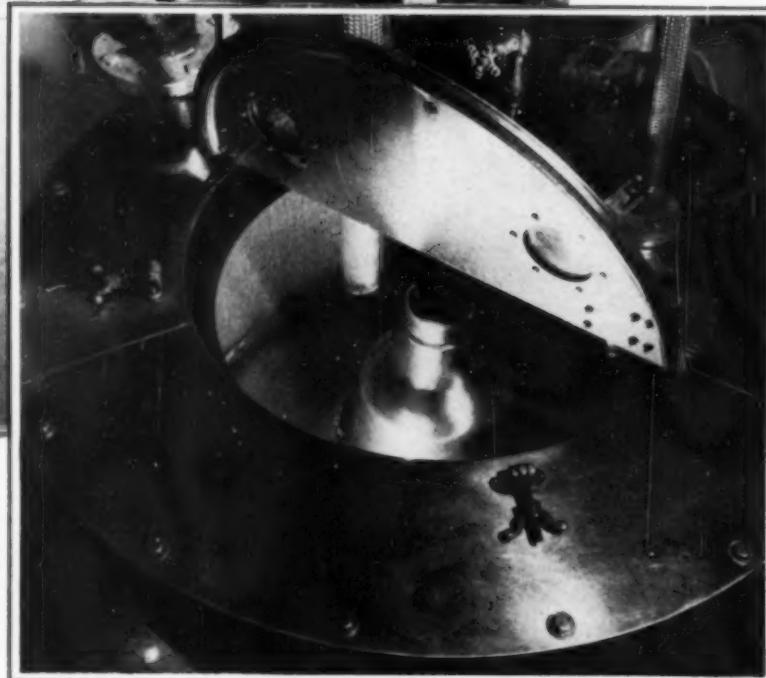
...first in FLOW METERS

FOR PRODUCT PURITY AND

Vitamin crystals are removed from a Stainless Steel Tolhurst centrifugal at the Merck plant. Merck operates many of these Stainless centrifugals, manufactured by American Machine & Metals, Inc., East Moline, Ill.



Immaculately clean, the interior of this centrifugal is all Stainless Steel.



REDUCED MAINTENANCE

Merck & Co., Inc. processes vitamins in

Stainless Steel centrifugals

Product purity is the first consideration of Merck & Co., Inc., in selecting equipment for processing operations at its big Rahway, N. J., plant. It's one of the major reasons why Merck makes such extensive use of Stainless Steel.

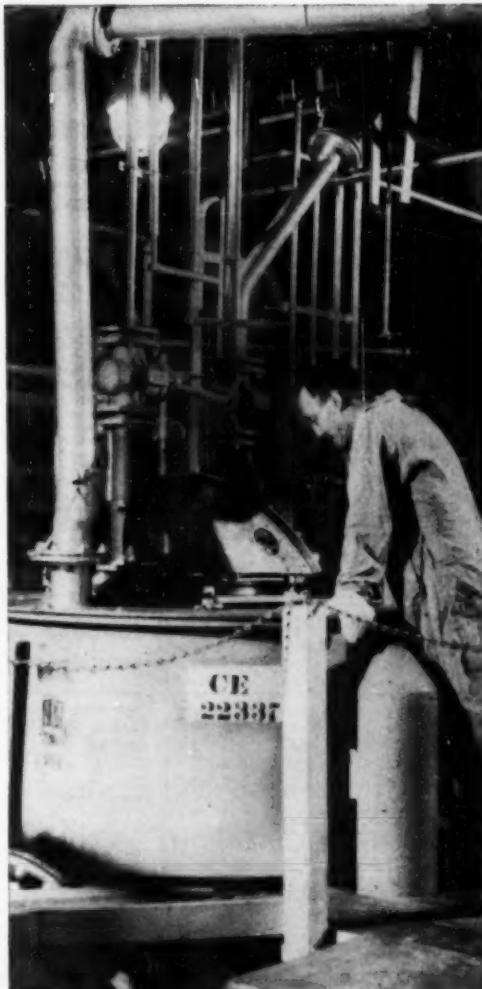
In the manufacture of vitamins, for example, slurry enters a Tolhurst centrifugal, made of Stainless Steel, through a Stainless Steel pipe. The centrifugal removes vitamin crystals from the mother liquor, which is pumped to further processing through a Stainless Steel sump and pipes.

A product that is 100% pure is the ultimate in such processing. Because Stainless Steel is completely neutral to the material being processed, it plays a big role towards achieving a high purity standard and eliminating waste batches.

Stainless Steel's resistance to corrosion is important from the standpoint of maintenance, too. Tolhurst Stainless Steel centrifugals have been in operation under severe conditions for periods up to ten years at the Rahway plant and give promise of many more years of additional service. The centrifugals are generally in intermittent but regular operation 24 hours a day, 7 days a week.

Wherever you need a strong, durable, corrosion-resistant material that will guard product purity and keep maintenance and replacement costs low, turn to Stainless Steel. And for the finest performance, ask your fabricator to use service-tested U-S-S Stainless Steel.

This centrifugal in the Merck plant is employed in the production of a vitamin which is used widely in pharmaceuticals and in enriching poultry and animal feeds. Slurry comes to this Stainless centrifugal from a Stainless Steel tank.



UNITED STATES STEEL COMPANY, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS • PIPE • TUBES • WIRE • SPECIAL SECTIONS

3-459

UNITED STATES STEEL



MONSANTO

Chemicals • Plastics



FOR YOUR INFORMATION

Every month Monsanto publishes three pages of pertinent information which may be helpful to you. This issue discusses:

Mildew Proofing
Ortho-Nitrochlorobenzene
Sulfuric Acid Fluid
Plastidione
Corrosion-preventing Paper
Dessert Recipes

Pinalite 5-5
Bacteriostatic Paints
Biological Resistance
Sodium Tripoly Phosphate
Soda Sodium Pyrophosphate
Phosphoric Acid

Additional information on any of these subjects will be provided by any Monsanto Sales Office in response to your request by coupon or letter.

Putting the right qualities in adhesives for bags, bottles or books

The trend is away from the old-fashioned glue pot. It's toward the modern adhesives that give efficient bonding between widely varied materials and meet the needs of high-speed machines for labeling, sealing or fabricating.

You can select the qualities you want in adhesives for bags, bottles or books by choosing a Monsanto Plasticizer. In the large family of Monsanto Plasticizers you'll find one or more to exactly fit your needs whether you're making hot-melt, tacky, nontoxic or heat-sensitive adhesives.

Monsanto Plasticizers serve in adhesives based on polyvinyl acetate, polyvinyl chloride, zein, casein, polyvinyl butyral, styrene, ethyl cellulose and polyvinylidene chloride.

When your customers call for adhesives to meet their special needs, investigate the qualities you can attain by using Monsanto Plasticizers. For information on the use

of Monsanto Plasticizers, which are available for prompt delivery, contact the nearest Monsanto Sales Office or mail coupon.

MONSANTO PLASTICIZERS FOR QUALITY ADHESIVES

For Tacky Adhesives:

Ortho-Nitrophenyl Dimethyl Phthalate
Dibutyl Phthalate
Santicizer® 140
Santicizer 160
Santolite® MHP
Santolite MS (80%)
Tricresyl Phosphate
Triphenyl Phosphate

For Heat-Sensitive Adhesives:

Diphenyl Phthalate
Santicizer 1-H
Santicizer 3
Santicizer 9

For Hot-Melt Adhesives:

Dibutyl Phthalate
Diphenyl Phthalate
Santicizer 160
Santicizer 8
Santicizer M-17

For Nontoxic Adhesives:

Santicizer 141
Santicizer B-16
Santicizer E-15



Monsanto laboratories develop

method of mildew-proofing vinyls

Monsanto Research has developed a new method of incorporating Milmer 1 into vinyl coatings. The process, which is easy to use, permits the inclusion of Milmer 1 without crocking or blooming in calendered, plastisol, organosol and solvent coatings. It may be put into the coatings, the fabric or both.

Milmer 1 is effective in controlling mildew in both supported and non-supported vinyls.

Large quantities of Milmer 1 now go into coated fabrics for military use. It is employed in vinyl-coated duck and complies with many government specifications, including: MIL-F-4143, MIL-D-10860, KK-L-136B, 24-C-20, MIL-P-3003, MIL-F-6107, MIL-D-10799, MIL-T-10168A, MIL-P-10404, and MIL-C-5462A.

Peacetime uses of Milmer 1 in coated fabrics include tents, tarpaulins, upholstery, collapsible boats, collapsible tanks, irrigation dams and numerous others.

If you are interested in preventing mildew in vinyl coatings, sheeting or insulation, investigate the Monsanto method of using Milmer 1. You can get complete details from the nearest Monsanto Sales Office or by mailing the coupon.

Research Chemists' Corner

You may find something new here

In your research to find new products or improve your present line, it may be worth your while to take a long look at Monsanto ortho-NITROCHLOROBENZENE, an

extremely versatile intermediate. The following chart illustrates its possibilities in industry:



Ortho-NITROCHLOROBENZENE has the following physical properties:

Molecular weight 157.56
Stability 10 min.
Color, light yellow
Crystallizing point 131°C. Min.

There may be additional uses for the versatile product. Quality chemists who are interested in doing some research with ortho-NITROCHLOROBENZENE can get samples by contacting the nearest Monsanto Sales Office or by mailing the coupon.

Is "The Mrs." worried about the length of your belt?

You don't have to give up sweets just because your waistline is getting to the point where your wife is worried about the length of your belt. Just have her make desserts sweetened with Monsanto Saccharin. She

doesn't know how? Well, mail the coupon and we'll send you a copy of the Monsanto recipe book. It contains nearly a score of recipes for various dishes sweetened with nonfattening saccharin.

Protection for metal parts

In the past, machine guns and metal parts of other military equipment shipped to Korea have been protected in transit by a heavy coating of grease. Removal of this grease has been one of the most tiresome of details . . . a detail no longer necessary, thanks to chemistry. A patented wrapper, in which Monsanto Dicyclohexylamine is used, prevents corrosion. For sources of supply, mail the coupon.

Monsanto planning to build 250-ton sulfuric acid plant

Working with Tide Water Associated Oil Company, Monsanto is planning construction of a jointly owned, 250-ton sulfuric acid plant at Avon, California. The plant

will employ the Monsanto-Ross-Wilde process of recovering water-white acid from petroleum sludge acids.

Refinery wastes, sludge and hydrogen sulfide will be piped from the adjacent Tide Water Associated Oil Company refinery. Most of the sulfuric acid produced will be piped back to the refinery where it will be used in processing aviation gasoline and other petroleum products. Any surplus will be sold to West Coast industries.

The Monsanto-Ross-Wilde process is a flexible, low-temperature method of recovering acid from refinery wastes. It recovers a high percentage of acid in the petroleum sludge, forming a gas that is higher in sulfur content than that obtained by burning elemental sulfur which now is in short supply.

If you are interested in constructing a similar plant, you may consult Monsanto Engineers without cost or obligation. For complete details, mail the coupon.

AROCLORS IN PLENTIFUL SUPPLY

Additional capacity, now completed, makes the AROCLORS* (chlorinated biphenyl and chlorinated polychlorobiphenyls) freely available . . . Some uses of the AROCLORS are included on this page—Technical Bulletins are available dealing with structural and application data. See coupon for listing.

Pliolite S-5 and AROCLORS

Used as standard plasticizers and resin extenders, the AROCLORS contribute fast-drying properties to Pliolite S-5—provide excellent protection against acids and alkali, moisture and other common corrosive influences. Widely applied to protective and decorative coatings for concrete and steel structures, railway tank cars, concrete floors and walls, stucco construction, wood and metal marine equipment.

SEND INFORMATION: Plasticizers for Adhesives. Mildew-proofing vinyls. Sulfuric acid plant designs. Corrosion-preventing paper.

SEND LITERATURE: Saccharin recipe book. Technical Bulletins No. P-115, "THE AROCLORS." No. P-124, "AROCLORS as used in chlorinated rubber." No. P-126, "AROCLORS as used in Pliolite S-5." No. P-131, "AROCLORS as co-plasticizers for polyvinylchloride."

SEND SAMPLE: Ortho-Nitrochlorobenzene.

Maintenance paints and AROCLORS . . . Other applications

The destructive action of water, acids, alkali and other corrosive influences are effectively resisted by metal-surface paints that are formulated with AROCLORS. These Monsanto chlorinated biphenyl and chlorinated polychlorobiphenyls also contribute nonflammability, superior adhesion, high gloss. In addition, the AROCLORS possess good electrical properties . . . Besides their application to paints, the AROCLORS are used in formulating modified and synthetic rubber coatings, lacquers, hot metal strip coatings, vinyl protective coatings, adhesives, fire-resistant coatings, wood-sealer formulations, marine paints.

Biological resistance and AROCLORS

In recent tests, Monsanto AROCLORS exhibited distinct resistance to fungi and bacteria. The presence of this resistance in AROCLORS indicates that further study of these commonly used plasticizers can prove highly interesting wherever various types of organism attacks are encountered. Excellent repellency of termites and other soil mites is another AROCLOR feature.

ASK FOR AROCLOR LITERATURE

Contact any Monsanto District Sales Office, or write direct, for any of the following Technical Bulletins—No. P-115, "THE AROCLORS" . . . No. P-124, "AROCLORS as used in chlorinated rubber" . . . No. P-126, "AROCLORS as used in Pliolite S-5" . . . No. P-131, "AROCLORS as co-plasticizers for polyvinylchloride."

Sequestering action and water-softening power of Monsanto Phosphates

The sequestering action of Monsanto phosphates—inactivation of calcium and magnesium water hardness—is a significant property of both Monsanto Sodium Tri-poly Phosphate (STP) and Tetra Sodium

Pyrophosphate (TSPP) . . . In detergent and cleaning operations, these Sodium Phosphates combine with the calcium and magnesium ions present in hard water. They form complexes with these ions—the complexes remain soluble in water, but will not react with other substances to form insoluble precipitates . . . They have the ability to regenerate or re-dissolve insoluble calcium and magnesium soaps. This property is of value where clothes containing a residue of insoluble curds are agitated in a solution of STP or TSPP. Fabrics are restored to their original clean condition.

Peptizing value of Monsanto Phosphates

An outstanding property of Monsanto TSPP is its peptizing value—that is, the ability to keep small particles of solids suspended in a water solution. This suspension action prevents the re-deposition of removed soil during the cleaning and rinsing cycle.

MONSANTO PHOSPHORIC ACID

Monsanto supplies phosphoric acid of high purity in concentrations of 75% and 85% H₃PO₄. 75% phosphoric acid is available in tank cars, stainless steel drums, barrels and carboys and meets Food Grade specifications. 85% phosphoric acid is available in stainless steel drums and carboys and meets N. F. specifications.

MONSANTO CHEMICAL COMPANY, 1700 S. Second Street, St. Louis 4, Missouri. District Sales Offices: Birmingham, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle. In Canada, Monsanto Canada Limited, Montreal.

*Reg. U. S. Pat. Off.



SERVING INDUSTRY . . . WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY
1700 South Second Street, St. Louis 4, Missouri

Please send, without cost or obligation, information, literature or samples as indicated at left.

Name Title

Company

Street

City Zone State

DE LAVAL

CP PROCESS PUMPS

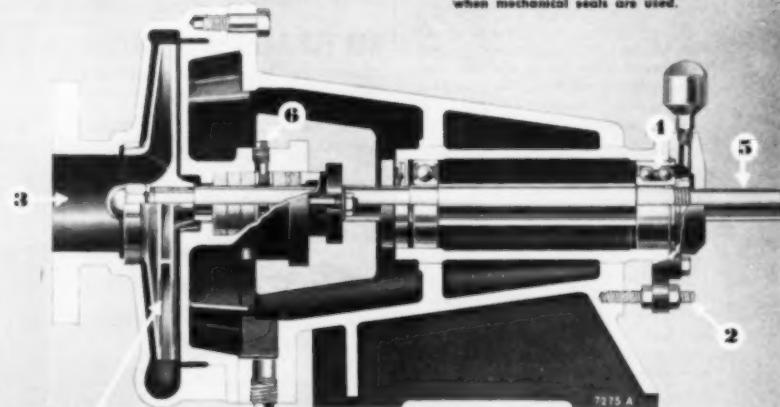
designed

Look at these design extras

SIZES TO 6"
CAPACITIES TO
1800 GPM
HEADS TO
200'



OPEN IMPELLER



CLOSED IMPELLER

De Laval CP Process Pumps are *versatile* on many counts. Impellers and seals can be quickly switched to meet changing service requirements. Adjustments for wear are simple to make. Repair parts are standardized. And, in addition, these pumps are specially designed for hundreds of general service process applications.

Careful selection of proven corrosion resistant materials permit CP pumps to handle practically all

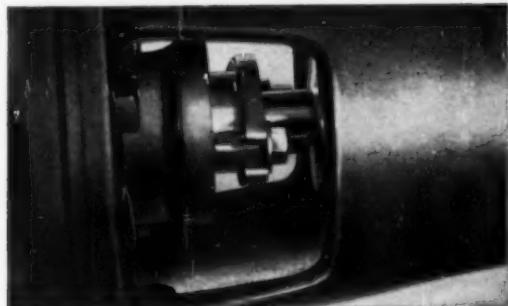
types of acids and alkalies. Whether liquids are hot or cold, viscous or corrosive, clear or filled with suspended solids, these pumps will keep giving efficient service for years.

Whatever your processing application, it pays to investigate the De Laval line of double-duty CP pumps. Bulletin 1125 gives complete data on these pumps, tells why they are . . . DESIGNED TO STAY ON THE LINE.

for double-duty performance



TWO PUMPS IN ONE! When service requirements change, you can quickly convert these pumps from closed to open impeller—and back again! As the cutaway drawing shows, all you need do is switch the pump volute and impeller. *There's no need to buy a whole new pump!*

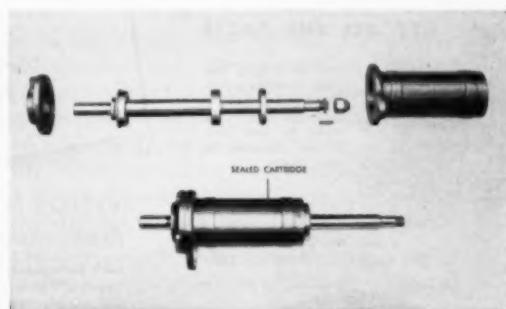


YOU CHOOSE THE SEAL! You can specify either mechanical seals or flexible packing . . . and change from one type to another in your plant. Gland faces are pre-machined and drilled for easy conversion to mechanical seals. Area around gland is large, easy to work in.

...and for time-saving maintenance

HERE'S EXTRA PUMP LIFE! On *closed-type*, turning the external adjusting screw moves entire rotor and impeller forward, permits you to adjust for proper clearance between case and *tapered* wearing ring. On *open-type*, simply face off worn parts of impeller and case, re-assemble pump and re-position impeller with adjusting screw.

DOUBLE-DUTY REPAIR PARTS! Two sizes of shafts, shaft lock-nuts, bearings, bearing cartridges and pedestals fit *all nine sizes* of De Laval CP Process Pumps. This versatile feature is another of the many De Laval design advantages that help trim costs by keeping your stock of repair parts at a minimum.



DE LAVAL



Process Pumps

DE LAVAL STEAM TURBINE COMPANY
TRENTON 2, NEW JERSEY

DL150

What do you do when you don't have the right size v-belt in stock?

1

Contact your supplier
for a replacement



...and wait for delivery
...wait—and watch production
stay at zero

3

Stock VEELOS...

2



Send someone to get
the required belt

...and pay your employee while he goes for
the belt
...pay through loss of production



...and always have the right size belt when you
need it

- ...any length can be made up from a 100-foot reel
- ...inventory is automatically maintained
- ...available from 350 distributors

GET ALL THE FACTS



This Veebos Data Book,
gives complete details
about construction, in-
stallation and uses.
Write for free copy
of this money-saving
book today.

MANHEIM MANUFACTURING
& BELTING COMPANY
602 Manbel St., Manheim, Pa.

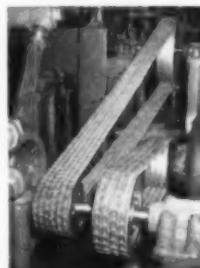


VEELOS in stock is Production Insurance

Belts for replacement always on hand—just
4 reels of Veebos in the O, A, B and C widths can
replace up to 316 different sizes of endless v-belts.

Link construction permits quick installation—
without removing outboard bearings.

Adjustability provides controlled tension on
each belt—vibrationless, full power delivery
is assured.



ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

Made in all widths in three types: regular, oil-proof, static conducting.
Also double V in O, A and B. Packaged on reels in 100-foot lengths.
Sales engineers in principal cities; over 350 distributors throughout
the country. VEELOS is known as VEELINK outside the United States.

Sulphur



Molten Sulphur flowing into the storage vat

*Thousands of tons mined daily,
but where does it all go?*



Look around you in any grocery store and what do you see—canned goods of all kinds! Soups, vegetables, fruits, berries! Believe it or not, you're looking at merchandise that consumed a lot of Sulphur in the making.

Tin cans are made of tin plate. Tin plate is made of sheet steel. Sheet steel is made with the help of sulphuric acid—pickling, as they call it, the process that removes scale preparatory to plating. In 1951, the sheet division of our great iron and steel industry is estimated to have consumed 140,000 long tons of Sulphur in the form of sulphuric acid. That in itself makes quite a dent in our supplies of Sulphur. Add to this almost as much more for treating wire rod, plate, strip, bars, etc., and you can see that to make finished steel, regardless of form, the iron and steel industry must use lots of Sulphur in the form of sulphuric acid.

Right here is an excellent example of the interdependence of all of our industries. To produce steel requires a lot of Sulphur. To produce Sulphur and other mined products requires a lot of steel. This interdependence of industries is one of the country's sources of strength.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N.Y.



Mines: Newgulf and Moss Bluff, Texas

TYGON

Versus

HF

"PROCEED with care" is sound advice wherever hydrofluoric acid is used or handled. This same advice also applies to the use of the versatile TYGON family of plastic compounds as protection against this highly corrosive acid. Properly used, TYGON does an excellent job of resisting HF in a range of concentrations and under a variety of conditions. Improperly used TYGON does not—cannot—give the maximum service possible.

The TYGON family consists of a series of polyvinyl resins carefully modified with other materials to give the ultimate in chemical resistance and physical properties. The many standard compounds available take the form of calendered or press-polished sheets, molded goods, extrusions, or protective coatings. Each form and each compound differs in its resistance to HF. Thus, to be effectively used, TYGON must be properly used.

In all exposures to hydrofluoric acid, TYGON may harden or discolor slightly, however, such minor changes do not affect protectability. In the case of TYGON sheeting, its resistance to hydrofluoric acid in concentrations up to 5% is excellent. Above 5% concentration, the resistance ranges from good to fair. Maximum service temperature for unprotected sheeting is 130°F. Above 130°F, an insulating sheathing consisting of carbon brick joined by a sulphur cement is recommended. With mixtures of HF and other chemicals, previous exposure tests or the counsel of U. S. Stoneware engineers is strongly advised.

TYGON sheeting finds use as a lining or covering for tanks, tank covers, diffusional towers, vats, bins, hoppers, troughs, blowers, impellers, fume hoods, and fume ducts. The sheets are also die-cut into gaskets, washers, and diaphragms for use in all types of process equipment.

When used as gasketing, TYGON resists all concentrations of HF at temperatures up to 130°F. This greater resistance results from only a relatively small area of the gasket being exposed. Higher service temperatures are possible, but depend upon the size, design, and specific use of the gasket.

As molded goods, TYGON takes the form of gaskets, grommets, washers, bumpers,

handles, closures, and miscellaneous parts and fittings. In these forms, the resistance to hydrofluoric acid approximates that of the sheeting. Once again, resistance to greater concentrations at higher temperatures is possible according to the size, design and intended use of the molded part.

As an extrusion, TYGON is primarily used as tubing or piping. However, extruded cord, channel, and tape also find use as gasketing, expansion jointing, packing or wrapping.

TYGON Tubing is widely used in the laboratory because of its clarity, flexibility, inertness, long life and ease of use. The larger sizes, up to 2" ID, are also becoming commonplace in the plant for use as flexible piping in acid transfer lines, as flexible connections, as inlet and outlet ports on pumps and filters, as syphon hoses, and as line desurgers.

In extruded form, TYGON resists hydrofluoric acid in concentrations up to 10% and at temperatures as high as 130°F. Above these limits or in exposures to HF mixed with other chemicals, the resistance varies and previous tests or the advice of qualified engineers is advised.

As a protective coating, TYGON is used in the form of a solvent type paint or as a plastisol (TYGOFLEX).

TYGON Paint is used to protect equipment, structural steel, walls, and ceilings, against the fumes and spillage of all concentrations of HF at temperatures up to 130°F. However, the limits of a thin film should be realized and only brief or intermittent contact is advised. Furthermore, any spillage should be immediately washed away.

TYGOFLEX is used as a heavy duty coating or in the casting or "slush" molding of intricate parts and fittings. Its resistance to HF depends on thickness of the coating, but usually is satisfactory against concentrations as high as 15% and temperatures up to 130°F.

Properly used, TYGON provides effective and economical protection against hydrofluoric acid. However, for maximum service, care in selection of form and compound, previous tests, and the advice of U. S. Stoneware engineers is recommended.

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THE Chementator

Reg. U. S. Pat. Off.

Prepared under the editorial direction of Joseph A. O'Connor, News Editor

Carbide's coal hydrogenation process

Aromatics are in for a resurgence that may parallel the current petrochemical boom. Coal hydrogenation will make this possible. Not only will aromatics be produced in greater volume than ever before, but coal hydrogenation will result in the first commercial production of many important aromatics, especially the higher homologs.

This is the future envisioned for coal chemicals by President J. G. Davidson of Carbide, whose company has just taken the wraps off its new coal hydrogenation plant at Charleston, W. Va. More than 17 years of research and over \$10 million went into Carbide's quest for a coal hydrogenation process.

But it was worth the effort. For Carbide's process not only yields the familiar aromatics now obtained from byproduct coking, but it yields far larger quantities than hitherto possible of the higher aromatic homologs.

In addition to benzene, phenol and aniline, Carbide's process will produce five to eight times as much naphthalene as byproduct coking; 100 to 200 times as much of the higher phenols, such as cresol; and 300 to 500 times as much of the higher amines, such as quinoline.

Davidson sees the commercial advent of these higher homologs opening a new domain for aromatics. Quinoline, for example, is one of the raw materials for making nicotinic acid. An even better example is methyl naphthalene, which the new process will make commercially abundant for the first time.

Ultimate capacity of Carbide's new plant will be 300 to 500 tons of coal per day. Even so, it's only a pilot plant. For if it works out as expected, it will be, according to Davidson, the mere "forerunner of other plants that will treat thousands of tons of coal a day and give to this country the same pre-eminence in the field of aromatic chemicals that it now possesses in petrochemicals."

New jobs for citric acid and hydrazine

Citric acid is an important raw material for volume production of the new anti-tuberculosis drug, isonicotinic acid hydrazide, made by Pfizer. So is hydrazine.

Pfizer, world's leading producer of citric acid, calls its new anti-tuberculosis drug Cotinazin. Enough citric acid is currently available for its manufacture.

Production of Cotinazin is expected to reach a total of 100 million tablets (50 mg. each) by year's end.

according to President John E. McKeen of Pfizer. The company is already producing the drug from coal-tar sources. Production from combined sources will reach a rate of 40 million tablets a month by the end of this month.

Cotinazin will be made from citric acid by a multi-step synthetic process, and it's expected that enough essential hydrazine will be forthcoming to keep planned production up.

Hydrazine is used by the Army Ordnance and other military services as a rocket propellant, but Army Ordnance has halted its research work on rockets until the need for hydrazine to manufacture the new anti-tuberculosis drug is met.

Rocket fuel research for Phillips

Phillips Petroleum Co. of Bartlesville, Okla., has quietly undertaken a research project for the U. S. Air Force. Its object: production of solid fuels to power rockets.

Rocket fuels will be big business in the future. They open new markets for chemicals produced from petroleum and natural gas.

Inventory controls: off and on

Inventory controls have been taken off 25 chemicals by NPA, reflecting a better balance between supply and demand. The chemicals range from aluminum sulphate and phenol to polyvinyl alcohol and perchloroethylene. They include aniline, maleic anhydride and phosphate plasticizers, as well as quinoline, styrene and glycerine.

At the same time, however, NPA slapped inventory controls on eight chemicals currently in tight supply. The eight: alkyl phenol resins, acetylene, butadiene, pine oil, selenium compounds, toluene, zinc ammonium chloride and zinc chloride.

Ceramic grades of fluorspar, cryolite and platinum have likewise been put under inventory controls.

Another whopping diffusion plant for AEC

Enough electric power is what the Atomic Energy Commission will be looking for when it picks a site for its proposed \$1 billion gaseous diffusion plant. The plant will eat up 1.8 million kilowatts at its operating peak.

While this is the largest single plant in the AEC expansion now being planned, its power requirements

THE CHEMICALATOR, continued

amount to less than half the total needed for overall additions.

The new diffusion plant is part of the proposed \$4 to \$5 billion AEC expansion program slated to go to Congress.

A site for the plant has not yet been picked. But the Atomic Energy Commission is concentrating on the Ohio River valley, principally because of abundant water and a potential supply of cheap electric power.

AEC, waiting for congressional approval, hasn't decided yet whether electric generating facilities for the gaseous diffusion plant will be built by private industry or the government.

Most of the \$4 billion to \$5 billion expansion will take place at present plants or those now under construction. The Paducah, Ky., AEC plant is expected to get much of the new construction.

Oxidizing with ozone

NEW PROCESS—Ozone is being used more and more in chemical processing to carry out difficult oxidations. Not only is it used in the manufacture of cortisone, but Emery Industries, Inc., of Cincinnati will use ozone to oxidize oleic acid.

Emery has just been given the green light by the government to start construction of a new \$2 million plant. It will be the world's largest single installation for the production of ozone. The ozone will be used in a new process, the result of joint research by Emery and Welsbach Corp. of Philadelphia, for oxidation of oleic acid.

PRODUCTS—This new plant will greatly increase Emery's output of azelaic and pelargonic acids, the two products that result from the oxidation of oleic acid. Emery is now the sole producer of these two acids.

Now, because of the efficiency of the new ozone process, larger volumes of these acids will be produced, and at lower cost. In fact, azelaic acid will be next to the cheapest higher molecular weight dibasic acid on the market today. Likewise, pelargonic acid will be the cheapest monobasic aliphatic acid of its type.

ADVANTAGES—In addition to its increased efficiency, the new ozone process has other advantages. It eliminates the corrosion problem encountered in the present chromic acid oxidation. It gives higher yields of purer products. It's more versatile. In fact, it's expected that Emery's new unit will be able to use a broader selection of raw materials; this will mean a greater variety of end products, especially as other uses of this unique oxidation process are developed.

MARKETS—Interest in this development is heightened by current investigations in the use of dibasic acids and their esters in synthetic lubricants for military and civilian uses. Such lubricants may consume much of the output of Emery's new plant.

Meantime, the use of azelaic acid in alkyls, as

well as in plasticizers for vinyls, cellulosics and synthetic rubbers, can be expected to expand as costs come down. The markets in alkyls and plasticizers have been proved in the years Emery has operated its chromic oxidation plant. Only limited availability and relatively high price have curbed expansion in these fields. Now it will be possible to get the low-temperature performance of many esters of azelaic acid even in relatively low-cost plastic materials.

Emery's research points to growing use of azelaic acid as a raw material for polyamides of the nylon type. In polyamides, azelaic promises superior water resistance.

Pelargonic acid already has important uses that will grow as more of it comes on the market at lower cost. For example, more pelargonic will be used in flotation—where it's highly efficient but has been too costly up to now.

Another possibility is increased use of pelargonic acid in perfumes and fine chemicals. Actually, the name "pelargonic" comes from a botanical term associated with geranium oil.

SOURCES—Amid current world tension, it's reassuring to know that oleic acid, the raw material for production of azelaic and pelargonic acids by the new ozone process, comes from animal fats and tallow. These are available in the U. S., and are currently in surplus supply. On the other hand, the closest counterpart of azelaic acid, one of the products, is sebacic acid, which is derived from castor oil, an imported raw material.

PRODUCTION—Emery's new plant is expected to be in operation within less than a year. By mid-1953 it will certainly be turning out azelaic and pelargonic acids by the new ozone process.

More cortisone coming up

Monsanto plans an \$18 million plant to produce cortisone by its own process, and Upjohn expects to build a \$3.3 million plant to make cortisone by its new fermentation process.

Monsanto isn't saying much about its process, most likely a synthetic one. But Upjohn claims its process sidesteps use of scarce desoxycholic acid from ox bile, substitutes progesterone, which can be made from plentiful vegetable and animal sources. The Upjohn process works also with other sterols—all abundant.

Shifting oxygen from the 12-position to the 11-position in desoxycholic acid requires the most difficult series of steps in the present partial synthesis of cortisone, a 27-step process used by Merck.

In the new Upjohn process, an oxygen is put into the 11-position in progesterone in a single step. The new 11-oxygenated steroid intermediate thus made from progesterone can be converted into cortisone.

Upjohn researchers put the progesterone in a "soup," which is a lactalbumin digest-dextrose-corn-

(Continued on page 110)

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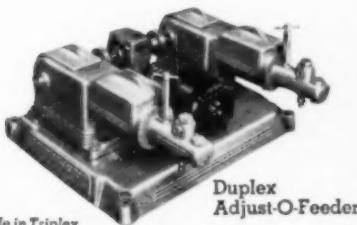


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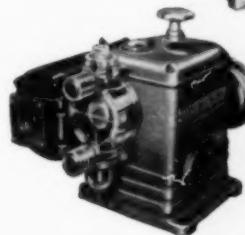
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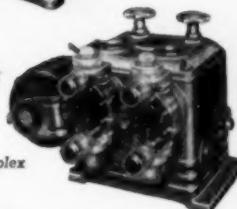


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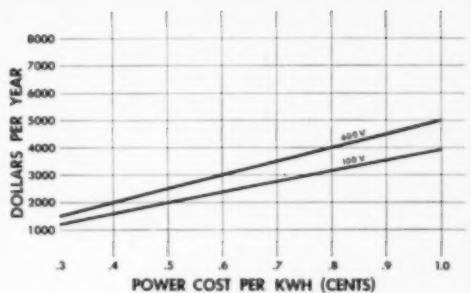
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THE CEMENTATOR, continued

steep medium. Mold is added, and the mixture ferments for 24 to 48 hr. The molds used by Upjohn belong to the same order as bread molds.

Oxygen can likewise be put into the 11-position of other compounds by Upjohn's fermentation process. These compounds can be made from vegetable sources such as stigmasterol, which comes from soybeans, or from animal sources, such as cholesterol.

Thus by introducing fermentation Upjohn may have opened the way to a simpler and cheaper production of cortisone.

More chemical plants for Western Hemisphere

American Cyanamid has organized a new corporation, Chemical Construction Inter-American Ltd., to design and build chemical plants in all nations of the Western Hemisphere, except the United States.

A wholly-owned Cyanamid subsidiary, the new company will have headquarters in Toronto, Canada, and its operations will parallel those of its sister company, Chemical Construction Corp., which designs and builds chemical plants in the U. S. and throughout the world.

Chlorine from byproduct hydrochloric acid

Hercules will convert byproduct hydrochloric acid to chlorine at its Brunswick, Ga., plant. H. K. Ferguson Co. will start construction of the recovery unit this summer, and it will be completed by the end of the year.

The unit will consist of a large compressor house, a reactor enclosure, drying equipment, condensers and pumps. Because the gases handled are corrosive, air entering the compressor house will be washed by venturi scrubbers, and the building will be kept under positive pressure. The reactor enclosure will be of structural steel and corrugated asbestos siding.

Reclaimed gases produced will be recycled in the process plant for production of toxaphene.

Superphosphates without sulphuric acid

Unless ways are found to produce superphosphates while using less sulphuric acid, the chances of reaching the new goals for phosphates are slim. That's the warning NPA sounded at a recent Washington meeting of phosphate industry executives.

NPA points out that by 1955 the Department of Agriculture's estimated requirement for superphosphates will reach 3,485,000 tons, almost 75 percent more than this year's anticipated production of 2 million tons, which is all that can be expected under the current limitation on sulphur imposed by NPA. And sulphur will be tight for years to come, according to NPA.

Sulphuric acid consumption could be almost halved, declares a Tennessee Valley Authority expert, by acidulating phosphate rock with a mixture of sul-

phuric acid and nitric acid. By ammoniating the resulting slurry, a nitrrophosphate is produced that contains nitrogen and phosphorus, both vital plant foods.

Methods used commercially in Europe and Asia for the production of superphosphates are cited by a Department of Agriculture spokesman. The methods are non-acid processes. They involve the alkali treatment of phosphate rock in electric furnaces or in cement-type kilns using small quantities of coal.

The four methods call for: (1) smelting of phosphate rock with or without alkali salts or silicates; (2) heating phosphate rock in a rotary kiln and then defluorinating; (3) heating the rock with magnesium silicate in an electric furnace; and (4) heating it with soda ash.

By adopting one or more of these methods, an NPA official states, the makers of superphosphates can meet the Department of Agriculture's projected requirement for phosphate fertilizers despite the sulphur shortage. Unless these methods are used commercially, he says, the goals may not be met.

Solvent extraction vs. continuous pressing

Solvent extraction is fast supplanting continuous pressing in getting oil from soybeans. At least 75 percent of the soybeans grown last year for crushing were processed in solvent extraction plants.

In 1940-41 screw presses handled about 74 percent of the beans processed and solvent extraction about 23 percent.

The yield from a bushel (60 lb.) of soybeans processed by screw presses is about 9 lb. of oil. The average yield from a bushel of soybeans processed by solvent extraction is about 10.5 lb. of oil. In 1950 U. S. soybean processing mills had an estimated total capacity of more than 225 million bushels.

Construction stopped on two expansions

There is no joy in Painesville, nor in Ashtabula either. Running into soft spots in caustic and chlorine sales, Diamond Alkali has halted its \$12 million expansion of chlorine-caustic capacity at Painesville, Ohio. And National Distillers has called off expansion of its sodium plant at Ashtabula, Ohio, after spending \$4 million.

The Diamond expansion would have more than doubled the company's capacity for producing chlorine and caustic by the electrolytic method. It would have enabled Diamond to abandon the lime-soda process for producing caustic.

When first disclosed in August 1951 the Diamond project was timetabled as a two-year job. Engineering had been completed at heavy cost to the company and H. K. Ferguson was well along with work on piling and foundations at the 20-acre site when work was halted.

Redeploying to meet the new situation, Diamond
(Continued on page 112)

HOW THE ROAR OF A JET LED TO A BETTER UNIT HEATER



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exchanger and burner
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ENDURO makes new Modine heater more durable, lighter, faster-acting

The use of heat-resisting stainless steel for jet engine exhaust parts gave Modine Manufacturing Company engineers an idea. Although gas-fired unit heaters never are subjected to jet engine temperatures or corrosive conditions, they are vulnerable to similar service hazards. In new Modine models, Republic ENDURO Stainless Steel is used for heat exchangers and burners. From now on, ENDURO construction will combat these former heater hazards—corrosion due to gas acids and contaminated atmospheres . . . high-temperature scaling and flaking, which weakened metal walls and clogged burners . . . rusting caused by condensation and atmospheric moisture . . . cracking . . . and rapid discoloration.

In addition, ENDURO has saved 50 to 200 pounds of weight per unit by permitting lighter gauge construction of exchangers and burners. And, with metal mass reduced, tube warm-up lag is minimized. Tests show that the new units actually deliver heat *within 5 seconds* of the thermostat's signal.

Chemical process equipment, of course, is subject to similar operating hazards. ENDURO Stainless and Heat-Resisting Steels can help overcome them for you, too. And, Republic metallurgists are ready to work with you, and with your equipment supplier, in adapting ENDURO to your own ideas. Call your nearest Republic District Sales Office, or write:

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THE CHEMICALATOR, continued

will shift a \$1 million perchloroethylene unit, originally part of the Painesville expansion, to its Deer Park, Tex., plant. The new unit, now in the design stage, will produce 25 tons per day.

National Distillers decided to call off its sodium expansion at Ashtabula because Procter & Gamble, a big customer, won't need as much sodium as anticipated for manufacture of alkyl sulphate detergents.

At its big Ivorydale plant outside Cincinnati and at its new Kansas City plant P & G will continue to use sodium reduction in the making of fatty alcohols for conversion to alkyl sulphates. But its Long Beach, Calif., plant will keep on using high-pressure hydrogenation, and its new Sacramento unit probably will do likewise.

In the competition between sodium reduction and high-pressure hydrogenation, sodium reduction has the edge in lower investment, but hydrogenation makes it easier to recover glycerine in the feedstock.

Cheap alkyl aryl sulphonates made from petroleum cut into the market for alkyl sulphates, further trimming P & G's sodium requirements. On top of that, the entire detergent business is currently trying to shake off a 10 to 20 percent slump.

Like Diamond, National Distillers isn't wanting in generalship. With an eye on the growing market for sodium peroxide, National Distillers has already worked out a process for its continuous production on a larger than pilot-plant scale. At present the output of sodium peroxide totals about 15 million pounds annually. But its use in groundwood bleaching, where it's moving in on hydrogen peroxide, is growing steadily.

Pennsalt keeps growing

Pennsalt, which has shelled out about \$30 million since war's end for expansion, will add another \$10.2 million in new plant by early 1953.

Last year, Pennsalt spent about \$6 million for expansion. Additions now under construction include a new unit for producing chlorine, caustic soda and anhydrous hydrochloric acid at Calvert City, Ky., at an estimated cost of \$8 million, and a doubling of Pennsalt's ammonia production at Wyandotte, Mich., at a cost of approximately \$2.2 million.

ADM sees green profits in chlorophyll

Archer-Daniels-Midland is going into the chlorophyll business. ADM has purchased Keystone Chemurgic Corp. and will acquire Chlorophyll, Inc.

Keystone Chemurgic, whose plant is at Bethlehem, Pa., is one of the largest producers of chlorophyll and xanthophyll, and is now in full production. Keystone, founded in August 1947, is a pioneer in the chlorophyll industry.

Chlorophyll, Inc., was organized a year ago and completed a plant at Neodesha, Kan., last January.

ADM expects to have this plant producing chlorophyll soon. Donald G. Carpenter, head of Archer-Daniels-Midland's new chlorophyll division, will assign some of ADM's top chemists and engineers to the job of speeding production at Neodesha. Chlorophyll derivatives are obtained from alfalfa by solvent extraction.

Major stockholders in Chlorophyll, Inc., were the Rystan Co., Inc., of Mount Vernon, N. Y., the Charles Bowman Co., New York, and Archer-Daniels-Midland. Headquarters for ADM's new chlorophyll operations will be in Minneapolis.

According to President T. L. Daniels, ADM plans to expand its production as the demand for chlorophyll increases, but will remain a supplier of raw material, staying out of the chlorophyll products business.

The chlorophyll products business has suddenly sprouted, enormously increasing the demand for the green stuff. Today, chlorophyll goes into everything from medical ointments and solutions to chewing gum, deodorants, mouthwashes, toothpastes, hair rinses, shoe insoles and dog foods. Sales of chlorophyll products topped \$20 million last year, will probably go over \$50 million this year and could reach \$100 million.

Who gets the Du Pont gravy?

Less than one-third of Du Pont's 71 plants put at least \$245 million into circulation in their six states during 1950 through purchases and payrolls.

The money in circulation consisted of \$94 million in purchases of materials and services by Du Pont and \$151 million in total payrolls. The 23 plants in New Jersey, Kentucky, West Virginia, Virginia, Tennessee and South Carolina employ about 40,000.

Here's the breakdown by regions: (1) New Jersey, where Du Pont has more plants than in any other state, \$43 million in materials and services bought in the state, \$68 million total payroll; (2) Kentucky, Virginia and West Virginia, \$44 million in purchases in the three states, \$60 million total payroll; (3) Tennessee and South Carolina, \$7 million in purchases in the two states, \$23 million total payroll.

Phosphate and potash get break on rail boost

The Interstate Commerce Commission has just granted the railroads the 15 percent increase in freight rates that they have been after. The increase applies to hundreds of items. But the ICC exempted a few items from the flat 15 percent increase, among them phosphate rock and potash.

Maximum increase on phosphate rock was fixed at 60 c. a ton and on potash at \$1 a ton. Thus savings are assured on all phosphate rock moving at rates of more than \$4 a ton, and on all potash at rates higher than \$7 a ton.

Practically all phosphate rock carried by rail from Florida and all potash moving east of West Texas are affected. Savings to industry, farmers and the public will come to \$1 million at least.

-End



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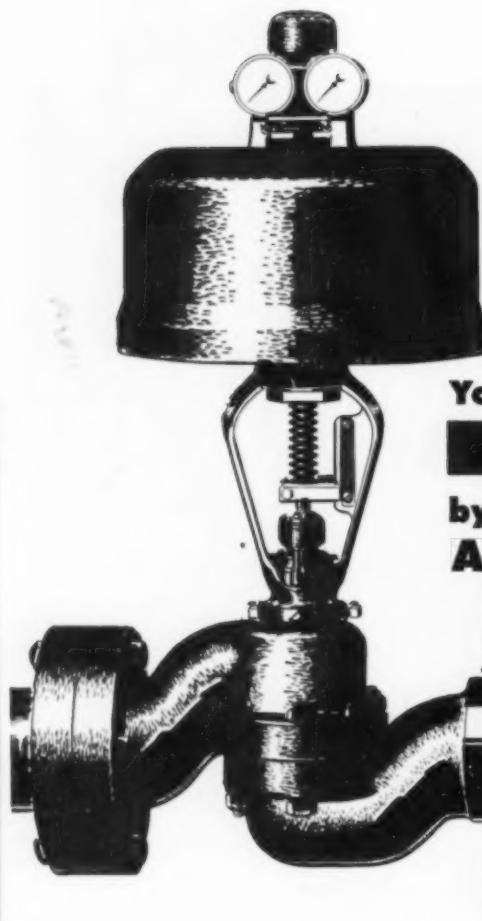
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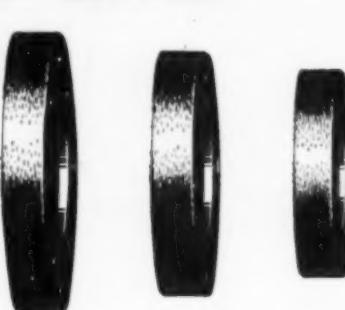
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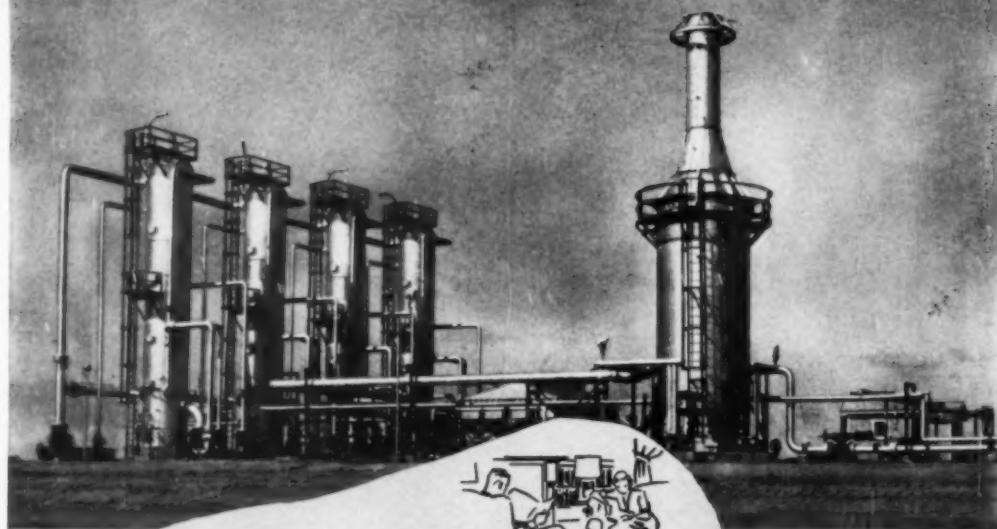
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Now... closer temperature approaches in heat exchange



WITH TRANE BRAZED ALUMINUM SURFACE

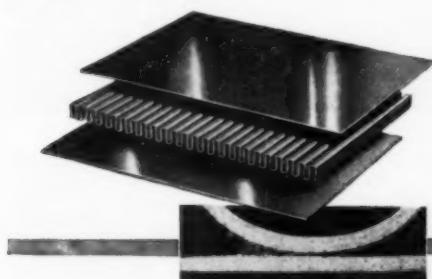
Now . . . even with a large temperature change or drop . . . you can obtain *temperature approaches of 5° to 10° F.*

TRANE Brazed Aluminum heat exchange surface makes it not only possible—but practical! That's because the new TRANE Brazed Aluminum packs up to 450 square feet of surface into a single cubic foot of space.

This huge amount of surface in a single unit makes maximum use of available pressure drop. And you don't lose pressure through connections.

TRANE Brazed Aluminum can handle heat transfer between three, four, five or more streams simultaneously—liquid to liquid, liquid to gas, or gas to gas. Temperatures from 500° F. to -300° F. Tested at pressures up to 1000 Psig.

Want more information? Contact your nearest TRANE sales office, or write The TRANE Company, LaCrosse, Wis.



MANUFACTURING ENGINEERS OF HEATING, VENTILATING,
AIR CONDITIONING AND HEAT TRANSFER EQUIPMENT

WHAT IS BRAZED ALUMINUM? A stack of flat plates and corrugated fins in layers, all brazed in perfect bond. Strong, light, compact and completely flexible. Illustration below shows strong fillet formed between fin and plate.

TRANE

THE TRANE COMPANY, LA CROSSE, WIS.
Eastern Mfg. Division, Scranton, Pa.
Trane Company of Canada, Ltd., Toronto
Offices in 80 U.S. and 14 Canadian Cities

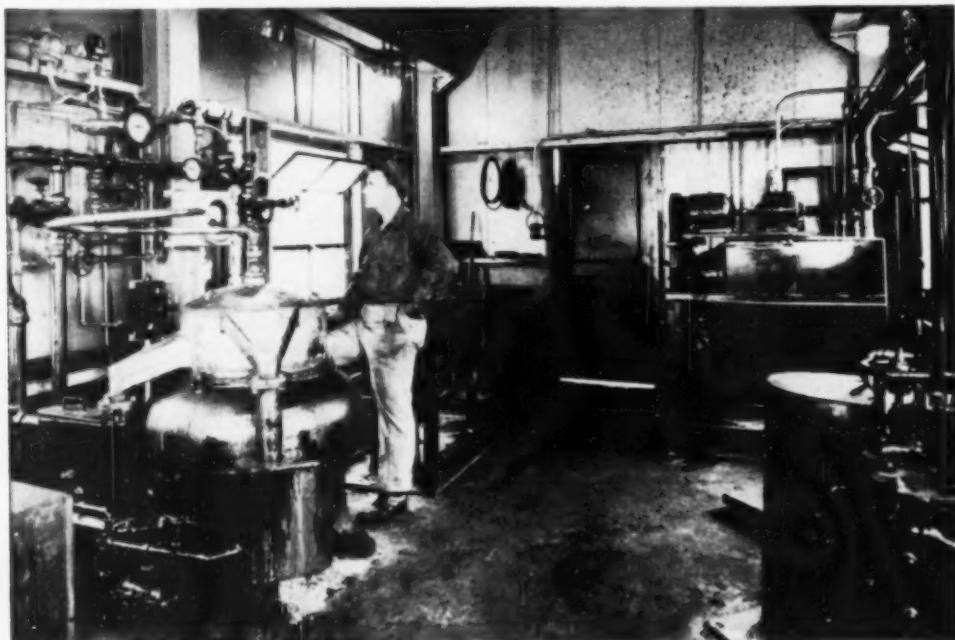
Unlocking the tar chain

Because the Sharples centrifugal process for tar dehydration produces a low viscosity tar of constant low moisture content; tar still operation is greatly simplified, and maximum production of light fractions is obtained. Operating and maintenance costs are reduced; initial investment and floor space are minimized—and a whole chain of valuable products is made available to producers of both coke oven and water gas tar.

Sharples centrifugal processes, in addition to tar dehydration, cover a wide range of processing—from caustic soda and vegetable oil refining, to continuous soap production. It would pay you to investigate the Sharples centrifugal naphthalene process.

Sharples centrifuges for the chemical and pharmaceutical industries, continuously separate, clarify, dehydrate, and classify by particle size—numerically, these applications run into the hundreds; economically, they are proving their efficiency and high productivity.

If you are developing, or wish to improve a process, get in touch with Sharples—seven different centrifuge types—your assurance of an unbiased recommendation.



Typical Sharples Tar Dehydration Process Installation

SHARPLES

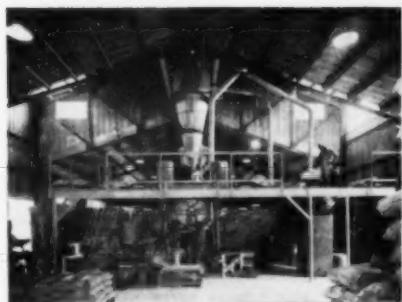


THE SHARPLES CORPORATION • 2300 WESTMORELAND STREET, PHILADELPHIA 40, PENNA.
NEW YORK • BOSTON • PITTSBURGH • CLEVELAND • DETROIT • CHICAGO • NEW ORLEANS • SEATTLE • LOS ANGELES • SAN FRANCISCO • HOUSTON



Chemical company uses these 12 Butler Buildings at Military, Kans., for storage of sacked ammonium nitrate fertilizer.

For Warehousing or Plant Facilities Today Buy Butler Buildings



Chemical processing plant at Memphis, Tenn.
Note full space use, roof to floor.

You can get new buildings quickly — when you specify Butler Steel Buildings . . . for plant expansion or new construction, for processing, packaging or storage facilities. And Butler Buildings offer these special advantages: (1) low cost . . . save up to 50% of the cost of building with commonly used materials; (2) little maintenance; (3) permanent . . . built better to last longer; (4) fire-safe, weathertight, wind-resistant; (5) ready to occupy in days instead of weeks . . . save on erection time and cost; (6) easily insulated, and at low cost; (7) wide range of sizes.

Build *today* with Butler Buildings. See your Butler dealer, or mail coupon below.

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at office nearest you:

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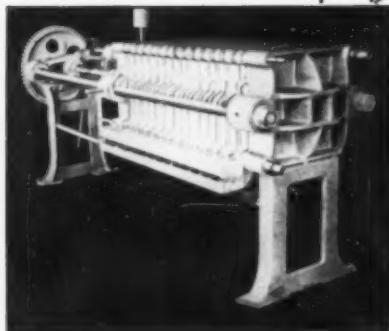
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it's a tradition



AND QUALITY IS A TRADITION WITH THE SPERRY FILTER PRESS!

Sperry has pioneered and developed the Filter press that today ranks as America's most widely used filter. This definite acceptance of Sperry engineering reflects the *tradition of quality* that for over a half century has set the standard for all Sperry equipment . . . as exemplified in these advantages of the Sperry Filter Press:

Greater Flexibility: Handles any kind of filterable mixture . . . requires less floor space . . . operates on low, medium or high pressure . . . can handle hot liquids without vaporizing . . . Uses filter paper or pulp, wire, wool, asbestos, glass, vinyon and other kinds of simple filter cloths.

Greater Performance: Produces maximum clarity . . . makes the driest cakes . . . can separate emulsions . . . delivers filtrate to higher level than filter . . . leak proof construction . . . can deliver cake in slab form . . . thoroughly washes the cake.

Greater Economy: Low first cost . . . low upkeep . . . low installation cost . . . low depreciation . . . long life.

For specific data regarding your own filtration problem, consult Sperry. Send samples of your material for test run.



SPERRY FILTER BASES

All types . . . all sizes. Plain or punched to your specifications. Besides cotton and paper, bases are furnished in wool, synthetics, glass and woven metals.

D. R. SPERRY & COMPANY BATAVIA, ILLINOIS

Filtration Engineers for over 60 years

Eastern Sales Representative: H. E. Jacoby, M.E.
203 E. 42nd St., New York 17, N. Y.; Phone Murray Hill 4-3381

Western Sales Representative: B. M. Pilhusky
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Phone DO 2-0375

SPERRY
FILTER PRESSES

IN STORAGE... OR IN TRANSIT...



SIMPSON MIXED MATERIALS

STAY MIXED

THIS you can depend on. Once materials are mixed in a SIMPSON Mix-Muller they stay mixed! Even after prolonged storage... or bouncing around in transit... where conventionally mixed materials tend to segregate or stratify... Simpson-mixed materials retain their constant stability.

Segregation can occur only where materials have been improperly mixed... where individual grains have merely been placed next to each other. Contrast this to mulling in a Simpson Mix-Muller, where each grain is subjected to a kneading, smearing, mulling action which actually blends component materials into one... where blending is intimate, thorough and uniform.

In addition, SIMPSON Mix-Mullers require less labor, less horsepower, and are safer to operate. You can obtain more information from a National Engineer. Write for details today.

DO YOU REALLY KNOW WHAT MULLING IS?

Watch the practiced technique of a chemist's mortar and pestle—the intensive rubbing and smearing actions—and basically, THAT'S MULLING!

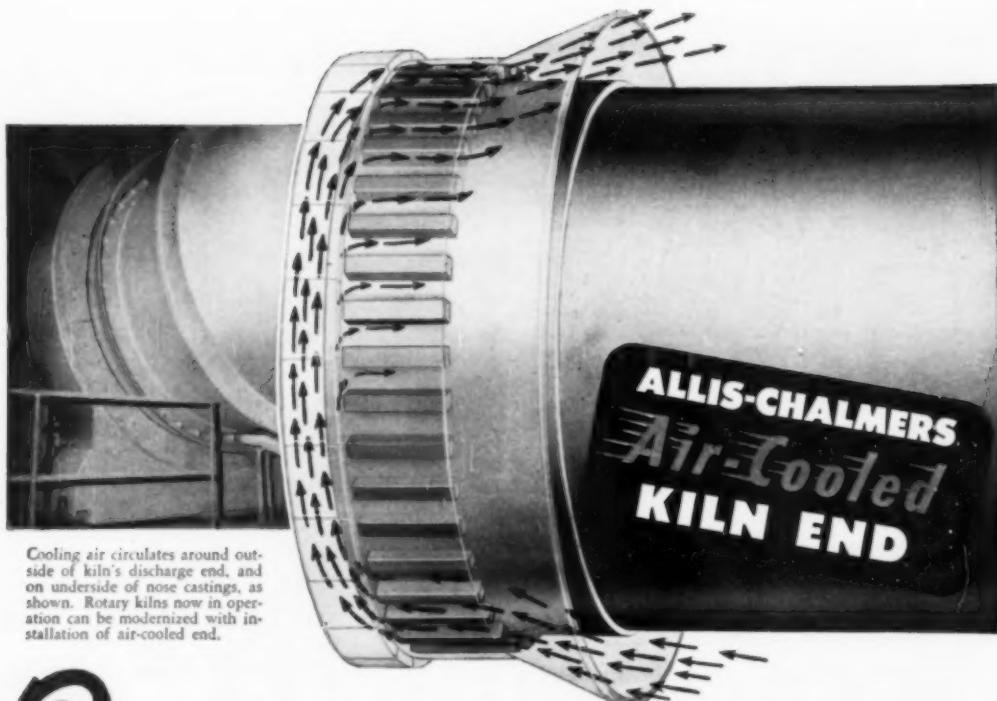
Mulling with a SIMPSON Mix-Muller utilizes a special pair of revolving mullers and plows mounted on a stationary pan. The mullers are adjustable and are supported by rocker arms. This leaves the mullers free to ride on the material creating a true mulling action as they revolve. The results are thorough, more accurate blending... unaffected by rough handling in transit, or in long storage periods.



SIMPSON Mix-Muller Division

1000 North Paulina Street, Chicago 6, Ill.





Cooling air circulates around outside of kiln's discharge end, and on underside of nose castings, as shown. Rotary kilns now in operation can be modernized with installation of air-cooled end.

Pays for Itself in 2 to 3 Years ... IN REFRactory SAVINGS ALONE!

BIG REFRACTORY SAVINGS . . . Discharge end of kiln shell stays cool, round and rigid. Refractory brick at discharge end lasts longer because air-cooled discharge end eliminates warpage or end distortion.

BIG MAINTENANCE SAVINGS . . . Fewer shut-downs to replace end brick. Less loss of valuable production time. Savings in brick, labor and downtime will pay for air-cooled end several times over during life of kiln.

BIG FUEL SAVINGS . . . Air-cooled discharge end makes possible a positive air seal between firing hood and kiln. Temperature inside kiln is not decreased by infiltration of cold air. Result — fuel savings!

A-3566

Get more facts from
the A-C representative
in your area . . . or
send for *Rotary Kiln*
Bulletin 07B6368A.
Allis-Chalmers, Mil-
waukee 1, Wisconsin.



ALLIS-CHALMERS

Pulverator is an Allis-Chalmers trademark.

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Throughout the World.



Pulverator



Vibrating Screens



Jaw Crushers



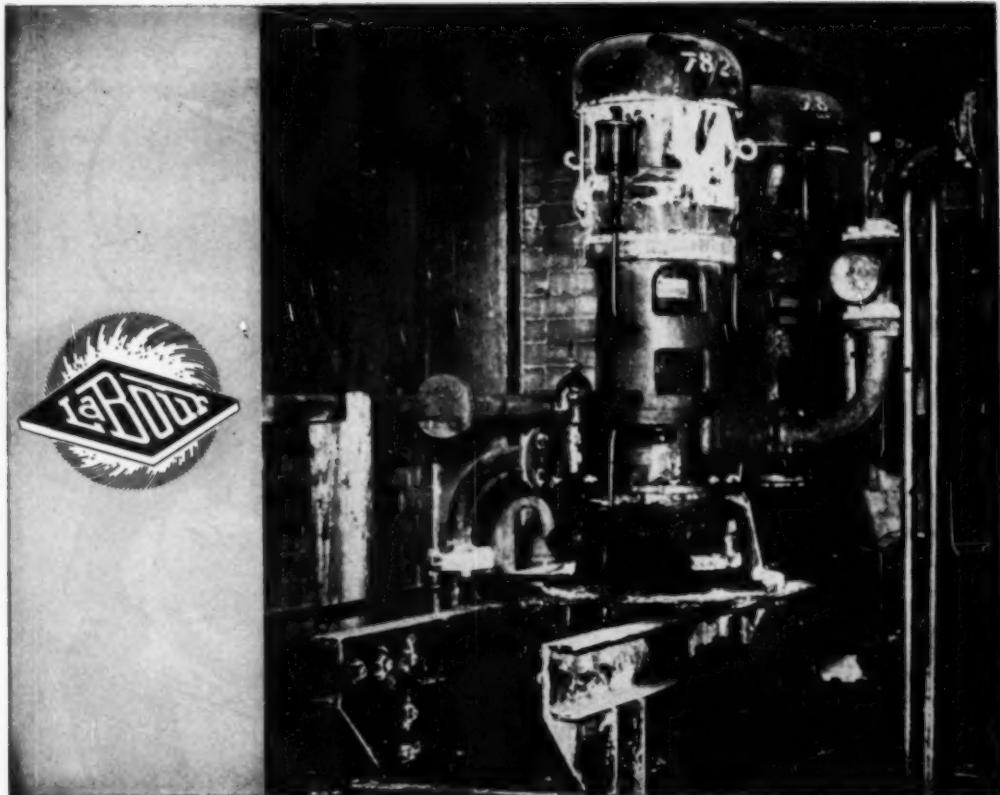
Gyratory Crushers



Grinding Mills



Kilns, Coolers, Dryers



Universal Answer to Tough Jobs

For more than two years now, the LaLabour Type G pumps pictured here have been on continuous 24 hour service handling 96% sulphuric acid at 65° C. They are operated in London, England, by that city's largest maker of sulphuric acid. These particular pumps were built in the British LaLabour plant, under the same strict supervision and test policy followed in the U. S. LaLabour operations.

All over the world, wherever chemical pro-

cesses place severe service demands on pump equipment, experienced engineers prefer LaLabour. With well over a quarter century of history now on record, LaLabour pumps have universally demonstrated themselves as the best possible insurance against costly interruptions due to pump failure. If you are interested in true operating economy based on twenty-eight years of proof, ask us about LaLabour pumps for your next job.

ORIGINAL MANUFACTURERS OF THE SELF-PRIMING CENTRIFUGAL PUMP

LA BOUR

THE LABOUR COMPANY, INC. • Elkhart, Indiana, U.S.A.

CHEMICAL ENGINEERING—May 1952





Get

something extra

when you buy

lead pipe and fittings

Quantity, size, type, physical composition . . . these are what you specify when buying lead pipe and fittings.

Do one thing more, however. Specify National and get certain extras...extras that take full advantage of lead's ability to withstand attack by corrosives.

For one example, when you specify National "Tubond" pipe and fittings, you get the corrosion resistance of lead combined with the strength of steel, in a virtually inseparable union of lining and casing. You get equipment designed to handle acids under difficult conditions of temperature, pressure and vacuum. You get full flow-way. You get greater security against leakage, because of extra lead on flange faces.

Extras in design, in fabrication, in careful chemical composition. To get them make this specification: National!



**Lead pipe and fittings
with a NATIONAL reputation
LEAD COMPANY**

New York 6; Atlanta; Baltimore 3; Buffalo 3;
Chicago 8; Cincinnati 3; Cleveland 13; Dallas 2;
Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6
(National Lead Co. of Mass.); Los Angeles 23
(Morris F. Kirk & Son, Inc.); Toronto, Canada
(Canada Metal Company, Limited)

*Reg. U. S. Pat. Off.



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industrial chemicals



- Electroplating Salts, Anodes and Processes
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Send for

this 32-page book—lists all the chemicals available thru
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THE HARSHAW CHEMICAL CO.

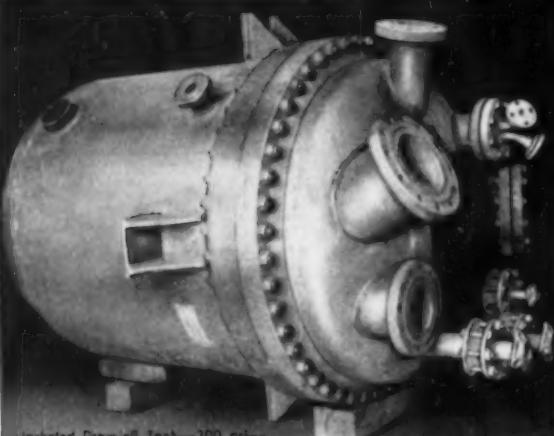
1949 EAST 97th ST. CLEVELAND 6, OHIO

BRANCHES IN PRINCIPAL CITIES

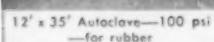
It's GRAVER
for pressure vessels
and code work!



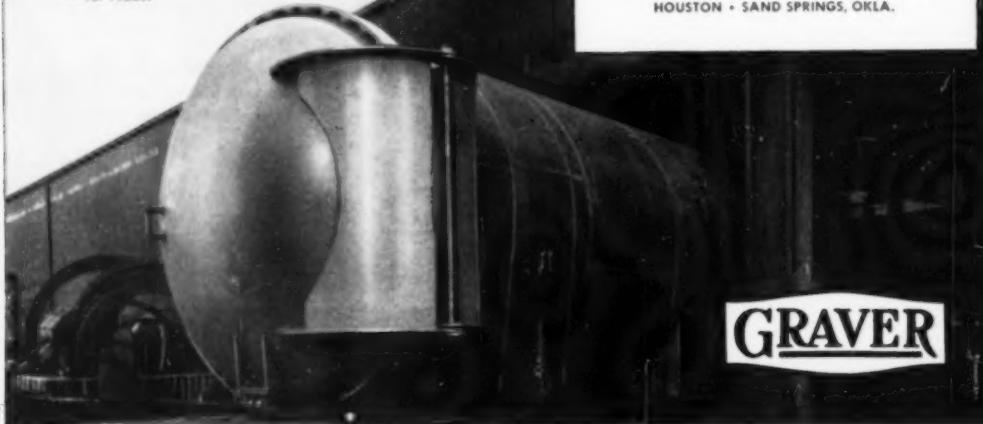
Two Quench Pots 3" x 21'6"-35 psi—
for petrochemicals



Jacketed Draw-off Tank—300 psi—
for petroleum by-products



12" x 35" Autoclave—100 psi
—for rubber



Processing plants today increasingly require specially designed pressure vessels. Graver has long been expert in the fabrication of code vessels, whether API-ASME, ASME or even more stringent specifications set by customers. Graver-built pressure equipment assures long life and safe, dependable service.

The steady flow of steel, clad and alloy pressure vessels through Graver's plants is suggested by these shop views. They indicate the many skills and services obtainable through Graver's high standards of welding craftsmanship.

GRAVER TANK & MFG. CO. INC.

EAST CHICAGO, INDIANA

NEW YORK • CHICAGO • PHILADELPHIA • WASHINGTON
DETROIT • CINCINNATI • CATASAUQUA, PA.
HOUSTON • SAND SPRINGS, OKLA.

GRAVER



...when you want the best

When you want a motor for use in explosive atmospheres, you *always* look for the Underwriters' label—assurance that the motor is approved for operation in Class 1 Group D hazardous locations.

Fairbanks-Morse Explosion-Proof Motors carry that label—your assurance of motor safety under this class of hazardous conditions.

Every Fairbanks-Morse Motor carries still another label—another assurance that you are getting the best in motor performance and service.

That label of confidence is the Fairbanks-Morse Seal.

When you look for electric motors—for standard or unusual applications—*always* look for the Fairbanks-Morse Seal. For over 120 years it has stood for the finest in manufacturing integrity—to all industry.
Fairbanks, Morse & Co., Chicago 5, Ill.



FAIRBANKS-MORSE,
a name worth remembering

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS
SCALES • HOME WATER SERVICE EQUIPMENT • RAIL CARS • FARM MACHINERY • MAGNETOS



THE
LONG LINE
OF VALVES

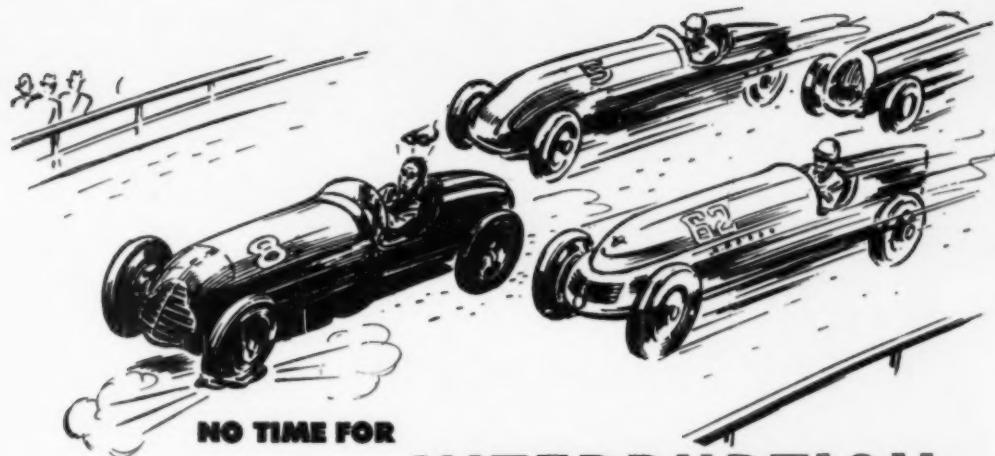


SIMPLIFY YOUR
PROCUREMENT
PROBLEMS

Phone the nearby OIC Distributor. The OIC Long Line offers the right valve for each job... prompt shipment... fast installation... dependable performance. Saves you time and money. The Ohio Injector Company, Wadsworth, Ohio.

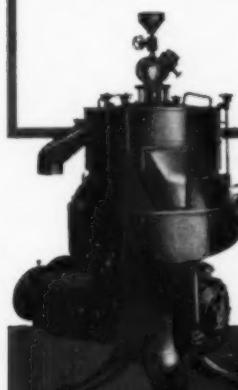


VALVES
FORGED AND CAST STEEL • IRON • BRONZE



**CONTINUOUS
OPERATION**
***is all-important
in processing***

- ***to speed
production***
- ***cut costs***
- ***improve quality***



INTERRUPTION

There are many places in every plant where motion should be continuous to be profitable. Unnecessary interruptions such as those due to outmoded methods of separating or clarifying are costly.

De Laval centrifugal machines not only separate liquids much faster than gravity and inefficient filters—but most of the time they do it *better*. Often centrifugal force will break emulsions that are apparently too tight to be broken by inferior means.

Problems of separation or clarification are not all alike. Many factors—specific gravity and viscosity of the liquids, the quantity of solids present in one or both liquids, the kind of solids . . . all these things influence the choice of the type of De Laval centrifugal to do the job. Each machine in the De Laval line has been built to effect *some* kind of separation or clarification better than anything else can. Any De Laval engineer will consult with you and recommend the right centrifuge to speed up *your* process.

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL

for **CONTINUOUS Separation with Centrifugals**



Why has the World's Leading Manufacturer of Pumps taken the "Pump" out of its name?

For 111 years "Worthington" has meant *pumps* to industry everywhere.

During this period, Worthington has developed a position of leadership in many related fields. Fourteen major product lines including pumps are manufactured in 21 plants throughout the world.

To those we serve, Worthington is *more than pumps*. That's why the world's leading manufacturer of pumps has changed its name from

WORTHINGTON PUMP AND MACHINERY CORPORATION

22

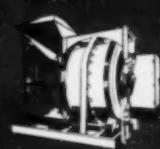
WORSHIPS

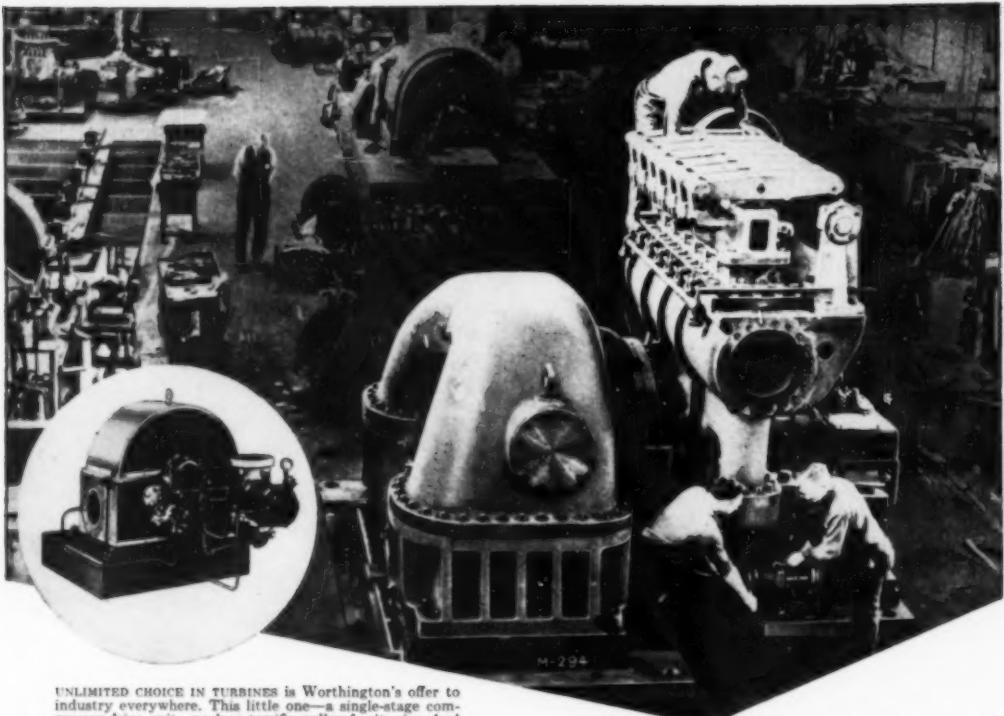


The Signs of Value Arrow
the World



Worthington Corporation





UNLIMITED CHOICE IN TURBINES is Worthington's offer to industry everywhere. This little one—a single-stage compressor-drive unit—packs a terrific wallop for its size. And that multi-stage 24,000-hp compressor-drive giant is one of the largest ever built for this type of service.

Single-stage midgets to multi-stage giants

Whether your turbine requirements call for the biggest or the smallest—straight condensing . . . straight non-condensing . . . extraction . . . mixed pressure extraction . . . low pressure . . . high back pressure . . . for mechanical or generator drive . . . with governors for constant or variable speed—Worthington has an answer.

Each Worthington turbine is designed to make the steam do more work, so you save power and money throughout its long life.

Learn more about Worthington turbines. Get the facts on why *there's more worth in Worthington* by writing to Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.

T.2.2



SINGLE-STAGE
TURBINES

MULTI-STAGE
TURBINES

TURBINE-GENERATOR
SETS

FEED WATER
HEATERS

BOILER FEED
PUMPS

SURFACE
CONDENSERS

A GREAT TEAM IN STEAM

WORTHINGTON

Steam Turbines



We help make 'em cold for hot service

At a Houston, Texas, plant operated by the Goodyear Synthetic Rubber Corporation for the R. F. C.'s Synthetic Rubber Division, it's Worthington equipment that helps maintain a constant brine temperature, ranging from 13 to 17 F, in the manufacture of "cold rubber".

Goodyear developments have done a lot to improve serviceability of cold rubber for tires, particularly for use on military vehicles.

The list of names that have joined them in selecting Worthington refrigeration includes: U. S. Rubber Co., Firestone Tire and Rubber Company, General Tire and Rubber Company, Minnesota Mining and Manufacturing Co., Ford Motor Company, General Aniline and Film Corp., North American Aviation Company, Celanese Corporation of America, Tidewater Oil Co., Rohm & Haas.

Investigate more worth
with Worthington
For air conditioning or refrigeration

eration, call upon Worthington... you'll benefit from an unequalled experience serving industrial and commercial applications.

The complete line of Worthington refrigeration equipment includes vertical (1 to 26 tons), Y-type (150 to 450 tons) and horizontal ammonia compressors (50 to 1,000 tons); Freon compressors (3 to 125 tons); centrifugal compressors (to 2,600 tons); gas-engine compressors, chillers, exchangers, condensers, pumps and other auxiliary equipment.

No other manufacturer makes so complete a line. A Worthington system is all Worthington-made—not just Worthington-assembled—assuring you of balanced operation and unit responsibility.

Consult Classified Telephone Directory for nearest Worthington distributor. Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Air Conditioning and Refrigeration Division, Harrison, New Jersey.



FOUR WORTHINGTON LTC-3 GAS ENGINE AMMONIA COMPRESSORS at Houston plant operated by Goodyear for the R. F. C.'s Synthetic Rubber Division. Units are rated 400 BHP at 320 rpm. They chill 24% calcium chloride brine down to desired 13 to 17 F range. Other Worthington equipment at the installation includes brine coolers, condensers and brine pumps.

*Reg. U. S. Pat. Off.

A.2.12

WORTHINGTON
Air Conditioning and Refrigeration

that added touch—

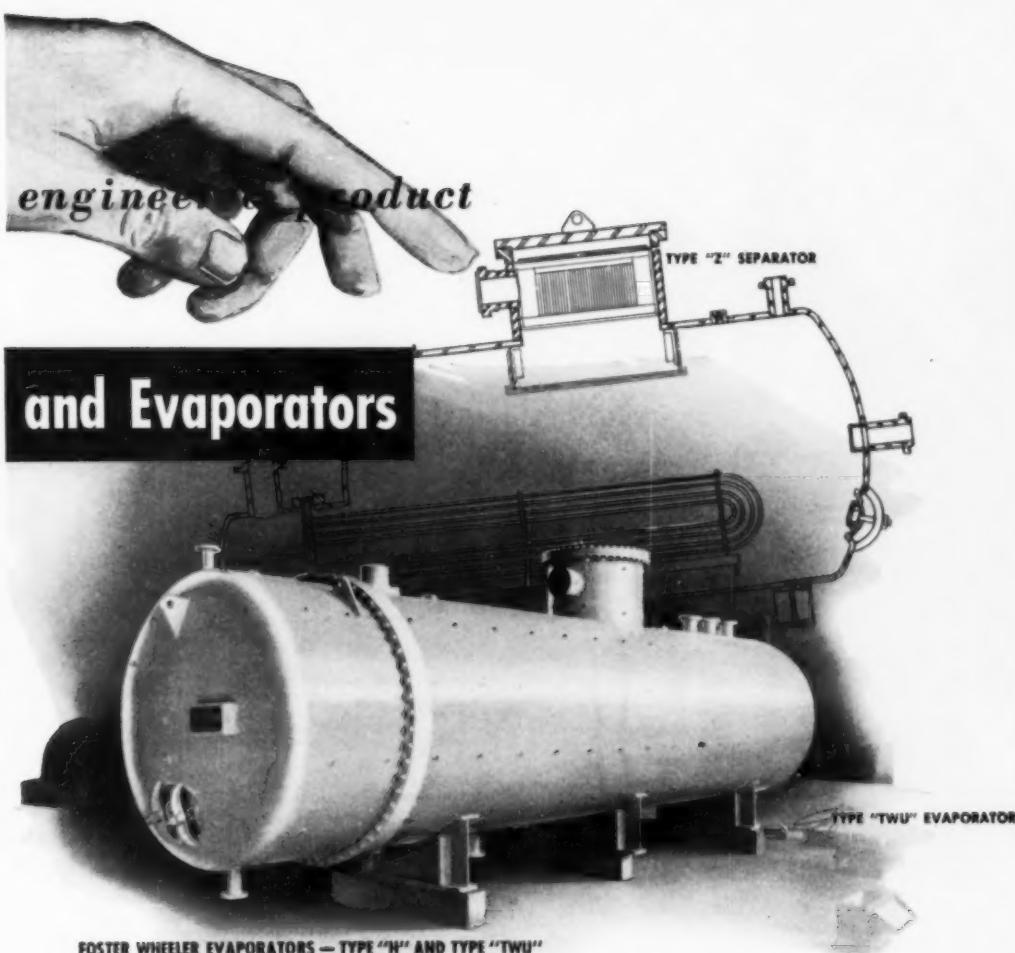


FOSTER WHEELER HIGH PRESSURE HEATERS WITH "LOCKHEAD" CLOSURES

Thousands of Foster Wheeler Feedwater Heaters giving optimum performance in steam-electric stations and industrial plants all over the country testify to the basic excellence of FW design.

In this case, "that added touch" is the FW "Lockhead" closure which provides separate means for supporting the head pressure load and the gasket compression load. Foster Wheeler feedwater installations include units capable of handling boiler feed flow in quantities up to and in excess of 1,000,000 lb per hr and design pressures up to 3,500 psi.

For further information, write to:



FOSTER WHEELER EVAPORATORS — TYPE "H" AND TYPE "TWU"

The "added touch" here is the development of a new design which gives you a choice in the selection of an evaporator ideally suited to your conditions. The design of evaporators for producing distilled water for central stations is basic to the efficient operation of a modern steam-electric power plant.

The FW Type "H" Evaporator was developed to handle raw and treated make-up and to give the best thermal and descaling operation.

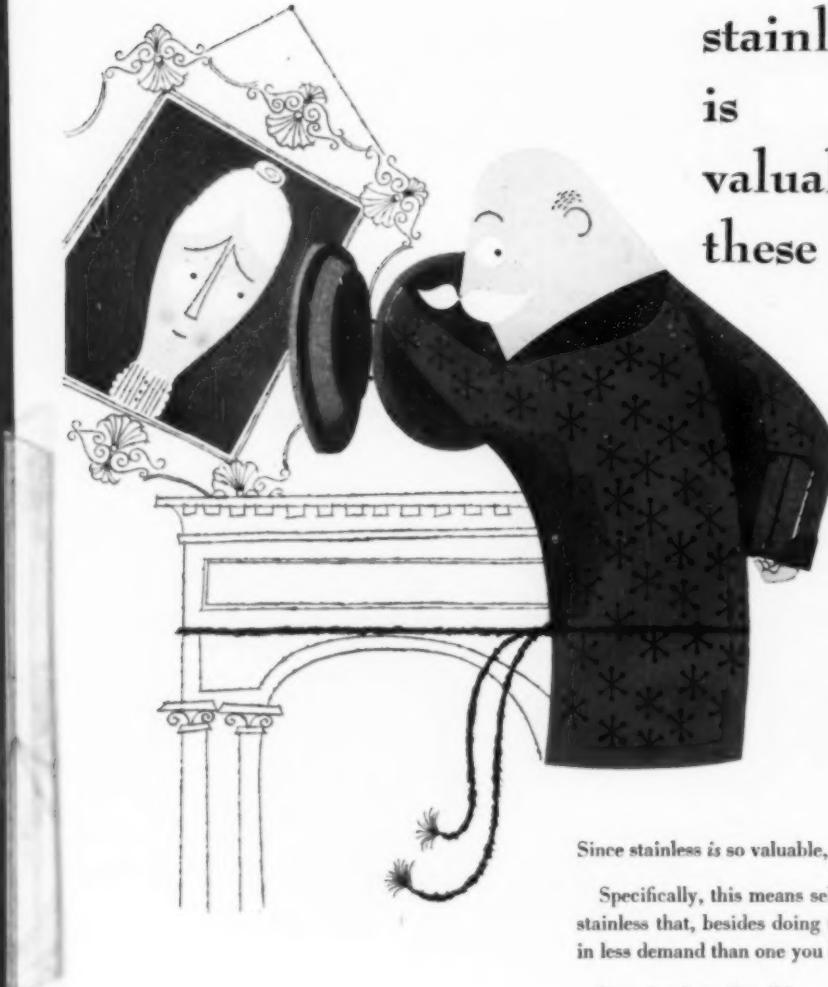
The FW Type "TWU" Evaporator, a more recent design, is particularly adaptable to the production of pure vapor from properly treated make-up.

Both types are offered with the Type "Z" Separator which was developed during World War II to meet exacting requirements of vapor purity.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK, N. Y.

FOSTER  **WHEELER**

stainless
is
valuable
these days



Since stainless is so valuable, plan to make it go further.

Specifically, this means selecting a grade or finish of stainless that, besides doing the job adequately, will be in less demand than one you have been figuring on.

Here is where Crucible can help you out. The matchless experience of our metallurgists and stainless fabricating specialists can help you get the most out of your share of stainless.

Call upon us to help you.

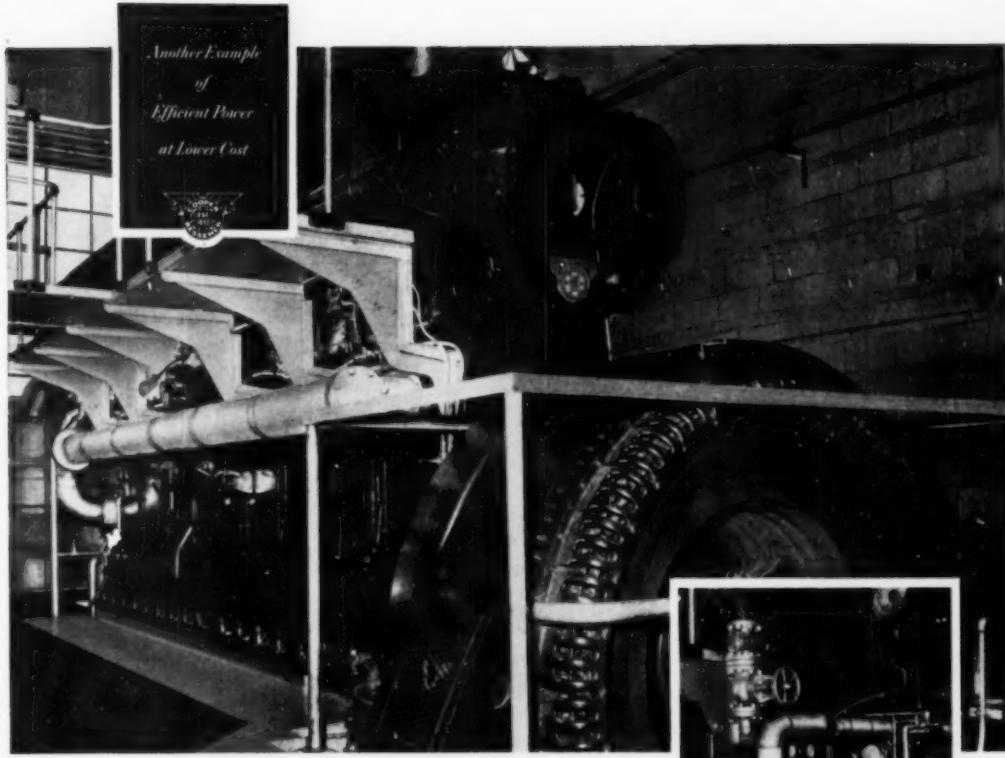
CRUCIBLE

52 years of *Fine steelmaking*

first name in special purpose steels

STAINLESS STEEL

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.
REZISTAL STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS



Latest of three Cooper-Bessemer LS-8 diesels in International Latex plant, this supercharged 1700 hp unit provides 40% thermal efficiency. End view at right shows piping setup for jacket water heat recovery contributing to 80% over-all thermal efficiency.

How they stretch dollars at International Latex

• Here's a diesel plant that is turning in amazing results—80% over-all thermal efficiency! The engine is a Cooper-Bessemer supercharged LS-8, installed in the International Latex plant at Playtex Park, Dover, Delaware.

To start with, this modern LS diesel exceeds 40% thermal efficiency—performance rarely equalled! On top of that, an ingenious jacket water heat recovery system captures for processing use another 40% of the total heat input.

In all there are three Cooper-Bessemer LS-8's in this International Latex plant—the supercharged unit shown above and two previously installed atmos-

pheric LS-8's. Later on these original LS-8's can be easily converted to supercharged operation to boost their output and to match the remarkable efficiency of the new unit.

Whatever your power needs may be, check with Cooper-Bessemer. Find out how much you stand to save by the best to be had in efficiency and long, trouble-free engine life.

The
Cooper-Bessemer
Corporation

MOUNT VERNON, OHIO — GROVE CITY, PENNA.

New York Washington, D. C. Bradford, Pa. San Francisco Houston,
Dallas, Greggton, Pampa and Odessa, Texas Seattle Tulsa Shreveport
St. Louis Los Angeles Chicago Caracas, Venezuela Cooper-Bessemer of
Canada, Ltd., Halifax, Nova Scotia Gloucester, Mass. New Orleans, La.



WHAT *Life-Lines* REALLY DELIVER IS MORE SERVICE...LESS SERVICING

New chemical booklet

answers important motor and control application problems

You'll see answers to typical problems like these:

*the problem of corrosion . . . of hazardous locations . . . of dust and dirt
. . . of outdoor service . . . of shock and vibration*

In addition, are discussions on lubrication, maintenance, installation . . . on centralized motor and control. In fact, it is the purpose of this booklet to analyze major motor and control application problems, and to provide solutions.

Also included, is information on Westinghouse motor and control equipment for chemical processing. You'll see why Life-Line chemical motors provide the best protection . . . how starters save servicing time. A comprehensive list of available literature with data is included, plus a postage-paid reply card for your convenience in ordering additional information.

Get the facts on the most complete and most advanced line of motors and controls available today. Ask your Westinghouse representative for your free copy of "Motors and Controls in the Chemical Industries," B-4792, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-21698

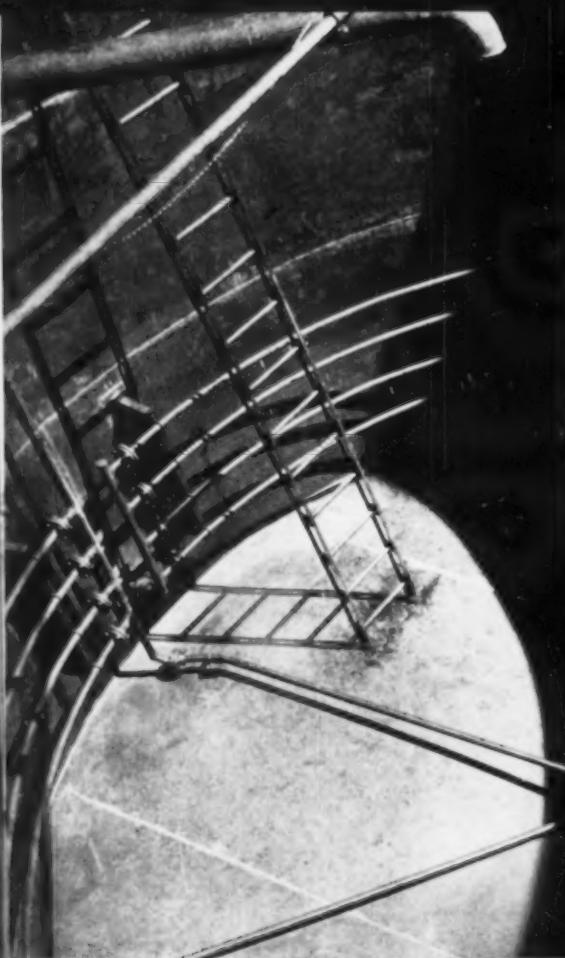
YOU CAN BE SURE...IF IT'S

Westinghouse

Life-Line

MOTORS and CONTROLS





Major Oil Refineries *use*

— 24 hr. a day, 365 days a year —

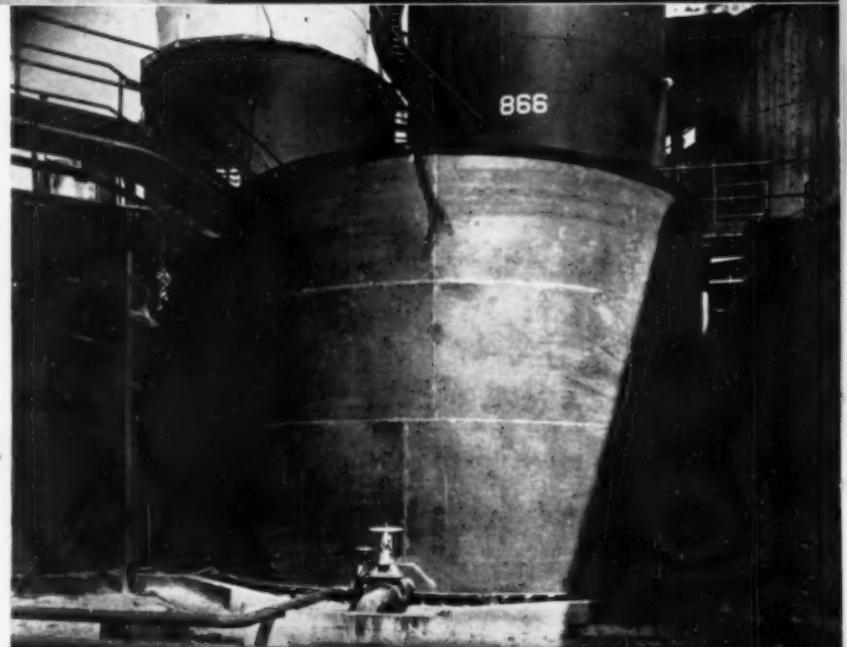
Inside view of tank showing construction. It was fabricated in three rings with Ampco-Trode electrodes. The top and middle rings are $\frac{3}{8}$ inch Grade 8 Ampco Metal plate. The bottom ring is $\frac{1}{4}$ inch Grade 8 Ampco Metal plate.

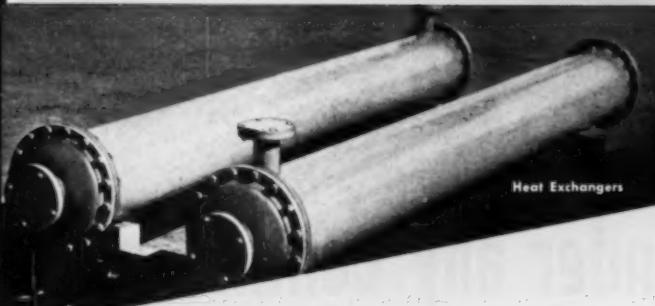
Inner coils are $1\frac{1}{2}$ inch Schedule 80 Grade 8 Ampco Metal Pipe connected with 150 lb. slip-on flanges.

Grade 8 Ampco Metal bolts and Grade 15 Ampco Metal nuts were used throughout.

Fabricators: Pacific Coast Engineering Company, Alameda, California.

Ampco Metal sulfuric acid sludge tank in operation at Shell Oil Co.'s Martinez, California plant. Tank is 20 ft. high and 24 ft. in diameter.



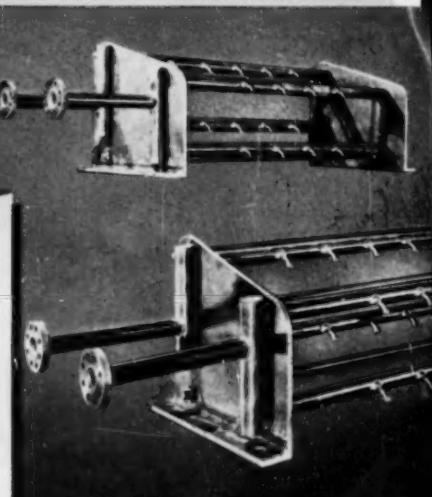


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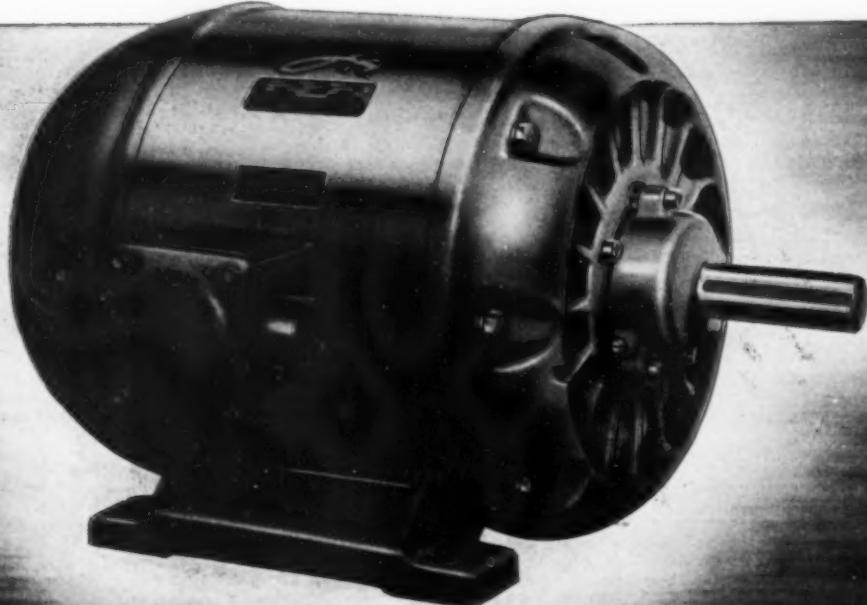
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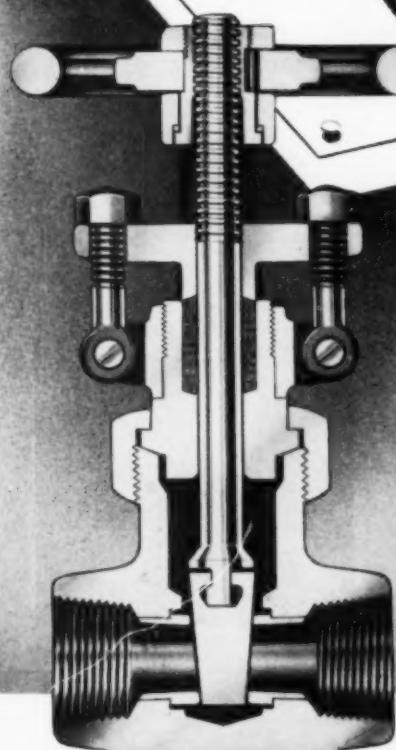
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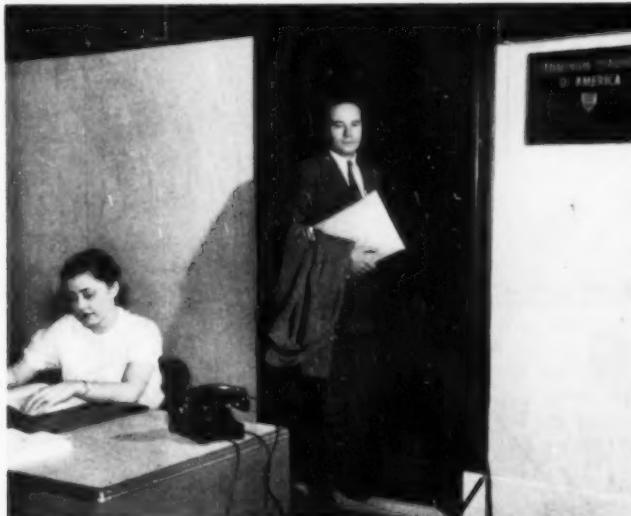


These two photographs illustrate the startling difference in flow pattern, occurring with and without the INTERNATIONAL STABILIZER BAFFLE, under exactly the same conditions. The shaft speed, propeller and rheological properties of the mix being the same in both cases . . . Impeller is center-mounted operating Counterclockwise at 1750 RPM. Turnover and overall agitation in above photograph is effected by splitting of helical stream, causing the flow to follow a radial path to the tank wall, and thence upward.



Above photograph shows the deep vortex and poor solids distribution, without the INTERNATIONAL STABILIZER BAFFLE. Note that there is little top to bottom turnover and inefficient flow pattern.

Memo from the Editor John R. Callahan



EDITOR Hoover worked with Alcoa to get the corrosion charts on p. 306.

Hoover Digs Up Corrosion Data

You've probably spotted what we've been doing recently in the materials of construction field. Well, here's the editor who does it—and some of his plans for the future.

Several years ago at a get-together of corrosion engineers I struck up a conversation with a young chemical engineer from American Cyanamid's plant down in Virginia. He lit into me right off the bat.

"I've been in production work for eight years now. I've worked in seven plants turning out everything from nylon to high explosives, from plutonium to titanium dioxide. And I can tell you this: corrosion's one big headache every chemical engineer is bound to have sooner or later—if not all the time. Can't you publish more dope—the helpful kind, I mean—on it?"

Then in the summer of 1949 the same chap—Morgan Hoover—wanted to know if there was a chance for him to become a *CE* editor. There was; Morgan had exactly the engineering experience (knocks and know-how is what we call it) we'd been looking for.

Right then and there we sat down

and figured out a long-range campaign to get more down-to-earth material on corrosion problems and materials of construction. Some of the articles you see now were planned way back then.

Morgan, for example, planned the series of corrosion charts we're now running (see p. 306 for aluminum). He actually started laying the groundwork for the series well over a year ago, published the first one last December.

This series is evidently hitting the jackpot with our readers who want a quick, simple way to pre-select materials. We emphasize, of course, that they're not intended—and never were—to take the place of actual test work and consultation with the materials manufacturers; these are always desirable in final selections.

When the series is completed a year or so from now, we think we'll have something that every chemical engineer will want to have for keeps. It looks that way now, so we're already

making the charts available in reprint form each month. As one engineer from Newark wrote me recently: "I've saved every copy of your Corrosion Forum since you started the department back in 1944, but I like what you're doing now best of all . . . now I want three reprints of each month's charts."

Morgan also took over the job of carrying on another long-standing *CE* tradition: the biennial reports on Materials of Construction that we began way back in 1923. This year's special issue in November will be our 15th in that series. Morgan actually buckled down to this job several months ago, is now working hand-in-glove with people and firms in the field.

Right now, I can say that our November Materials of Construction report will be something special—a fresh approach to a subject never really tackled before in an all-out way. We're pretty much excited about it.

Actually, though, one of Morgan's big day-to-day jobs is to go after and get feature articles on corrosion and materials of construction—and you've seen more of these in recent months.

In this issue, for example, you'll find an unusual article on p. 149, written especially for us by Penn Salt's corrosion-expert Bob Pierce. This article (which Morgan has been discussing with Penn Salt for close to a year now) will almost certainly go down in corrosion history as the article-of-the-year. It sparks a new approach to the subject of corrosion control and its economics. We're hoping to follow up with more like it.

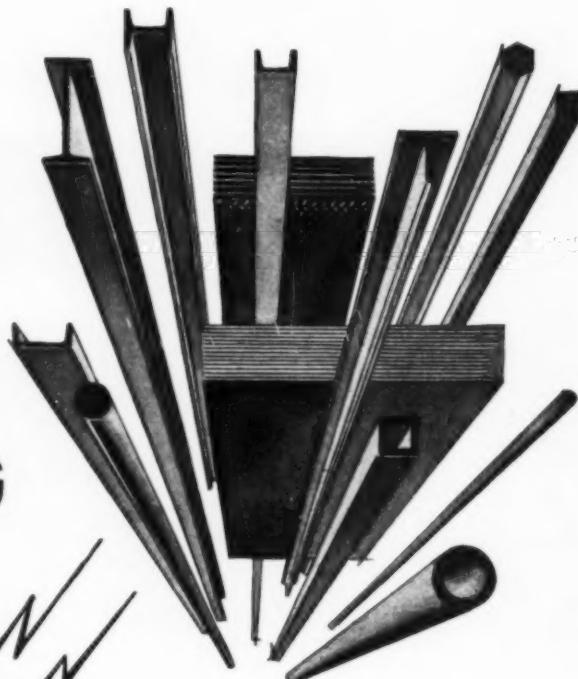
Now I've told you something of the editorial material Morgan is responsible for and how that campaign we mapped out years ago is beginning to pay off (with much more to come). But what about "Corrosion Editor" Hoover himself?

Morgan, of course, is a chemical engineer (Rensselaer, '41). And he has the distinction of being the only ex-football player on *CE*'s staff; at Rensselaer he played end on the varsity team for three years. He also held an alumni scholarship for two years.

Morgan began to pick up his unusual production experience right after he got his Ch. E. degree. He started off at Du Pont's nylon plant at Seaford, Del., back in 1941 when nylon was still the big fiber news.

(Continued on page 368)

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SIDNEY D. KIRKPATRICK, Editorial Director

JOHN R. CALLAHAM, Editor

Chemical Engineering

WITH CHEMICAL & METALLURGICAL ENGINEERING

MAY 1952

New Throne for Old King Coal

In its earliest days the synthetic organic chemical industry was almost entirely dependent on coal-tar raw materials. Lacking our vast hydrocarbon resources in petroleum and natural gas, the Germans obtained their crudes and intermediates from the byproduct coking of coal and lignite. Until about thirty years ago the rest of the world followed, sheep-like, in the German tradition. Then in the early twenties a few hardy pioneers among American chemical and oil companies began to experiment with the more abundant and purer hydrocarbons of petroleum. From these simple raw materials we now produce billions of pounds of synthetic aliphatic chemicals. But we are still dependent, in the main, on coal carbonization for our aromatics. And in recent years demand has so far exceeded supply that new non-coal-tar sources have had to be developed, especially for benzene, xylene, phenols and cresols.

Now there is encouraging prospect that the tables have been turned—that the organic chemical industry will once again pay homage to Old King Coal. Earlier this month we had the privilege of inspecting Carbide's new coal hydrogenation "pilot" plant at Charleston, W. Va. Here as much as 300 to 500 tons of coal can be processed to produce much larger quantities of the more valuable chemical raw materials than have ever been possible heretofore. Compared with by-product coking of coal, the new Carbide process will yield 5.8 times as much naphthalene, 100-200 times as much of the higher phenols, and 300-500 times as much of the higher amines.

One asks, quite naturally, is there a market for such vast quantities of aromatic chemicals? The answer, according to Carbide President J. G. Davidson, will be found in the records of the industry that 30 years ago pioneered the production of such aliphatic chemicals as ethylene oxide, ethylene glycol, cellosolve and the ethanolamines—for which there were then no known commercial uses. Today's sales of these four chemicals alone total more than two billion pounds per year. Why, he asks, can't the American chemical industry look forward to comparable successes in the field of new aromatic chemicals?

While the Bureau of Mines and the petroleum

industry are debating the economics of coal hydrogenation as a source of motor fuels, Carbide has plowed more than \$20 million and seventeen years of hard research into coal hydrogenation as a source of chemical raw materials. There is a vast difference in the two projects—in objectives and approach. One looks to government operation or subsidy. The other stands on its own feet, to succeed or fail as it serves the needs of American industry and the American people. For our money the choice is for private enterprise.

Instrumentation for Progress

Two thoughts appropriate to the editorial theme of this issue can be gleamed from many in Dr. Vannevar Bush's challenging paper on "Trends in Engineering." Speaking before the joint meeting in New York to celebrate the forthcoming Centennial of Engineering, he forecast tremendous progress yet to be made in the application of automatic controls in industry. But he warned: "We can dream of automatic machines in many places; yet our dreaming needs to be very practical indeed, for there is no panacea here. In fact there is a multiplication of problems, for as we improve our handling of materials by the use of automatic devices, we require not less labor, but better labor, labor skilled in more diverse ways. We require, too, keen thought in order that the more abundant product made possible by a given amount of capital, labor, and management may be so attractive to the public that it will be readily absorbed in increasing quantities and will render the whole economy more sound because of the technical changes that have occurred."

The second reference, in the same vein, was to a highly interesting trend in instrumentation. Here, he said, "there is a cumulating effect when new powerful instruments are introduced, for facility at measurement itself produces new knowledge and new products. It was not so long ago that one found complicated instruments only in scientific laboratories and even there rarely. Today in industrial laboratories we find electron microscopes, tracer techniques, mass spectographs, television techniques, ultraviolet methods for extending the capabilities of the microscope, and a host of other devices. Moreover we find these used as tools in every

day exploration, and we find them being manufactured in little independent, progressive manufacturing units all over the country. It is one of the most encouraging developments in this time."

Will Engineering Abdicate?

Another challenge by Dr. Bush: Is engineering as we have known it in the past in danger of being taken over by the applied-scientists? Have engineers become so set in their narrow grooves that they are concerned only with practical utilization of long established principles? Is there a tendency today to turn to the engineer only for those things that can already be found in the handbooks, and to turn to the applied-scientist for the novel approach through new and pioneering activities?

The great wartime research administrator doubtless had in mind the experiences in radar development at the Radiation Laboratory at M.I.T., or with the groups that worked on the atomic bomb at Columbia, Chicago and California. He cited proof that the applied-scientists can readily become engineers yet the reverse is much less frequent. With regret he noted that "only too often the young man with a scientific background proved more flexible under novel circumstances than the young engineer. . . . Even physical chemists in that environment, reacting to the stress and change all about them, became first radar men and then engineers."

Chemical engineering, in our opinion, suffers less than other branches from the stultifying effects of compartmentalization in training and experience. Flexibility, versatility and resourcefulness are essential characteristics of those who pioneer in the chemical and process industries. We cannot push forward toward wider and more intensive applications without thorough grounding in the underlying sciences of chemistry, physics and mathematics. But to the degree that we are crystallizing our knowledge and procedures, there is a lesson for us all in Vannevar Bush's words of warning. Truly "it would be a calamity, not only for the engineering profession, but also for the public at large if the engineer should abdicate his true position in society by failing to meet expanding demands and opportunities."

Costs Up, Profits Down

In recent years business profits have provided a large proportion of the money needed for new plants and equipment. Rising costs are now putting a squeeze on profits which in turn puts a squeeze on the funds available for capital expenditures. Our economists tell us that this is perhaps the most neglected or most abused economic fact in this country today.

It is also evident that a squeeze on profits deflates the element of business optimism which seems to be an essential ingredient of a thriving program of capital

investment. Studies made by the McGraw-Hill department of economics seem to prove that the general state of business optimism, uncertainty or pessimism has a much more controlling influence on capital outlays than the economic logic of the situation indicates it should have. But no one has yet discovered how to give the logic the right of way. The fellow who first does that—and it will probably be a salesman—will make a major contribution to the welfare of the nation.

Your Most Valued Neighbors

Cleveland industries have launched a most important educational program. They have set out cooperatively to show the members of the local draft boards just how seriously defense work can be hobbled by a shortage of skilled artisans. Chairmen and other influential board members are taken on educational tours through local plants and given opportunity to see and talk with draft-age apprentices. So far the program has been largely confined to the pattern-making industry, which is so vital to metal working and defense production in Cleveland. But we see no reason why the same procedures could not be applied in other communities and other industries. Research laboratories and pilot plants concerned with war work might present convincing evidence of the essential occupations of younger chemists and engineers. Isn't it worth trying?

Something New to the Army

Last month we had the privilege of attending the first meeting of Army Chemical Center's all-soldier Enlisted Specialists' Chemical Engineering Club.

This club—something new to the U. S. Army and probably to the armies of the world—is made up of enlisted men assigned to Chemical Center under the Army's scientific and professional personnel program. It is open to those men—a total of close to 250—who qualify as chemical engineers.

Idea of the club started with the soldier-engineers late last year. Then Cpl. John Ward and Pfc. Kenneth Vander Voort wrote Du Pont's Dr. Thomas H. Chilton, past president of the American Institute of Chemical Engineers, and told him of their idea. He urged them to go ahead.

Brig. Gen. William M. Creasy, Commanding General of the Center and himself a chemical engineer, encouraged the group. Dr. Duncan MacRae, chief consultant to the Chemical and Radiological Laboratories, took a personal and active interest.

We were encouraged—and highly impressed—with what we saw and heard at this meeting. Attendance by those eligible was close to 100 percent, the esprit de corps just as high. We believe the club itself is a sign of Chemical Center's progress in making better use of its enlisted chemical engineers.

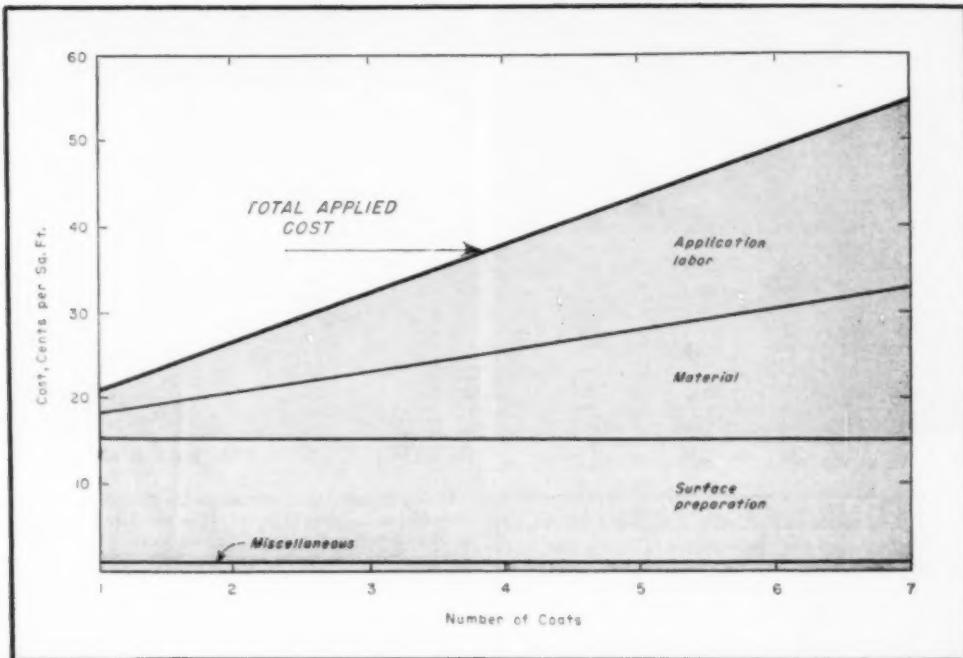


Fig. 1—Applied cost vs. coats. Values are average; material varies from 1 to 10 c. per sq. ft. per coat, 2.5 c. being a popular average.

PENNSALT GIVES:

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Select a three-coat painting system that will give enough build per coat for a 5-mil minimum total thickness. It's simple, and supported by the most comprehensive evaluation yet made of general purpose systems in chemical-industrial atmospheres.

ROBERT R. PIERCE

Three Coats—No More, No Less

At the start, it was realized that the minimum number of coats for general industrial maintenance painting should be three. This is because the number of coats required to insure practical freedom from coinciding pinholes of each coat is three—a fact confirmed by years of experience, but largely unknown or ignored on both.

There is no point in exceeding three coats, either. One reason: each additional coat over three will increase maintenance painting costs an average of 17 percent (Fig. 1), with no compensating increase in service life (provided the thickness standard described below is met). Another reason for not exceeding three coats: for general maintenance painting it is difficult enough to get three

coats on properly without insisting on any more.

Therefore, and especially since there are satisfactory three-coat systems available, the following discussion will be confined to three-coat systems for general plant maintenance.

Seven and eight-coat systems, catalyzed or accelerated short-working-life coatings, baked coatings, or paints requiring other special mixing, compounding or treatment that may be justified for special uses usually cannot be justified for general use.

The three-coat general purpose coatings must give an adequate performance over corroded wire-brushed steel, as ideal surfaces cannot be practically or economically produced on all plant areas using this type of paint protection. In many chem-industrial exposures producing dense adherent scale saturated with process contaminants, sand-blasting has proved no more expensive than thorough wire-brushing. Sand blasting will increase paint life two to four times over that obtained by wire-brush surface preparation.

ROBERT R. PIERCE, corrosion engineer with Pennsylvania Salt Manufacturing Co., made the evaluation on which this article is based in cooperation with Kenneth Tator of Kenneth Tator Associates, protective coating consultants.

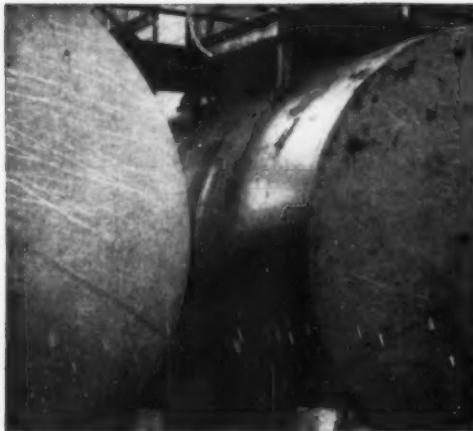


Fig. 3—Left-10 mils, right-3 mils. Both chlorinated rubber.

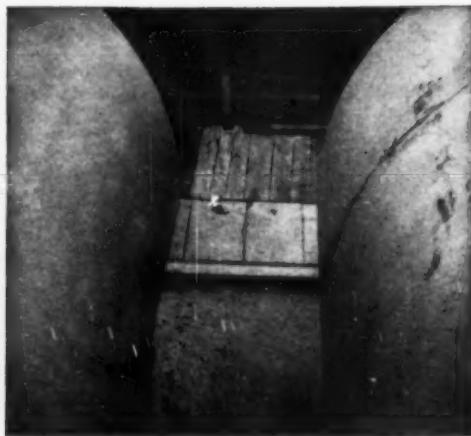


Fig. 4—Left-6 mils, right 3 to 4 mils. Both vinyl systems.

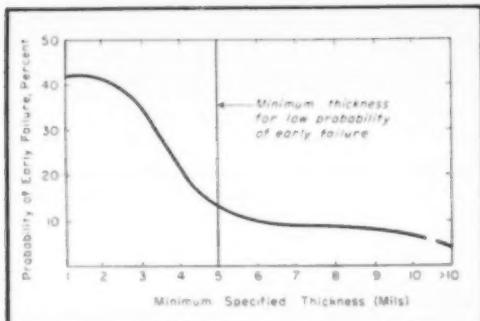


Fig. 2—Below 5 mils probability of early failure is high.

Thickness—5 Mils Minimum

Final dry paint thickness is a more important determinant of performance than number of coats, and the number of coats is of concern only to insure non-coincidence of pinholes and as a practical index of the final thickness that will be obtained with any specified paint material.^{1, 2}

Fig. 2 presents the probability of early paint failure at various minimum dry coating thicknesses as recorded by 337 performance determinations of 62 proprietary material formulations under a variety of chem-industrial exposures. It is significant that each of the paint systems included have a long record of successful use in normal industrial exposures, and that each was applied as a multicoat system according to the recommendations of the manufacturer. Criteria for early failure were significant deterioration over edges, welds, and projections within 10 weeks of exposure.

From Fig. 2 it is clear that, if no minimum thickness specification is imposed, the probability of securing useful protection from the available "chemical-resistant" coatings and paints is only 58 out of 100 or 58 percent. No appreciable improvement is obtained by increasing minimum thicknesses to 3 mils, but between a 3 and 5-mil thickness improvement is pronounced. Between minimum thicknesses of 5 and 6 mils the curve flattens off at failure probabilities of less than 10 percent.

It may be concluded that minimum thicknesses for useful performance should be set at no less than 5 mils total dry thickness over the corrodible base metal. The relationship demonstrated in the figure has been analyzed individually for each type of exposure and for each basic type of paint. While there is some slight variation from the depicted curve caused by differences between paint formulations, and greater differences according to environment, no such deviation in any case was of sufficient magnitude to justify an exception to the relationship shown.

This establishment of a 5-mil threshold thickness does not necessarily imply that continuous films cannot be below this thickness. On the contrary, it's established³ that threshold thickness of synthetic base coatings over steel is seldom greater than 1 mil. This work was done by coating plane surfaces and is consistent with the 5-mil minimum established here. The two apparently discordant sets of data are correlated in that it appears necessary to apply at least 5 mils of coating over plane areas in order to insure at least 1 mil over edges, welds and prominences.

Verification of this 5-mil rule is found in studies of paint performance on production equipment. Fig. 3, for example, shows two acid storage tanks both painted with the same chlorinated rubber paint system over sand-blasted surfaces. The paint on the tank at the left measures 10 mils and shows no deterioration after 3-years' exposure. The tank at the right, with a paint thickness of 3 mils, shows numerous patches of rust after 2-years' exposure.

Fig. 4 shows two more acid storage tanks, in the same bank as those of Fig. 3, both coated at the same time with identical vinyl systems by the same applicator over sand-blasted steel. Paint on the tank at the left measures 6 mils and is in excellent condition after 18-months' exposure. The tank at the right, with a paint thickness of between 3 and 4 mils, is starting to show rust break-through. This photo illustrates the danger of using number of coats as a criterion of thickness. Both tanks had the same number of coats of the same paint system. Difference in thickness was undoubtedly due to differences in thinning, spray adjustment and rate of spraying.

Minimum thickness requirements, therefore, should always be made a part of any paint application specifications. Non-destructive determinations of thickness are quickly and easily made by means of a magnetic gauge such as the pocket Elco or the portable General Electric.

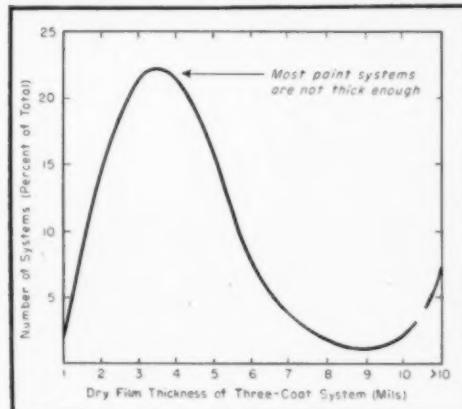


Fig. 5—42% chance of 5-mil thickness with random buying.

Build per Coat

The 62 paint materials included in these results, which represent a reasonable cross-section of chemical-resistant maintenance coatings on the current market, were applied as three-coat systems according to the recommendations of the manufacturers. The system thicknesses were determined and summarized in Fig. 5. This probability curve shows that paint systems offered today predominately fall between 3 and 4 mils, or an average of 1.0 to 1.3 mils per coat.

Random buying without regard to resulting film thickness will result in only a 42 percent chance of obtaining a paint system which will yield a safe 5 mils or greater in the economical three-coat system. Such procurement more probably will produce a three-coat system yielding 3.5 mils, or an average of 1.2 mils per coat. Such a system will require five coats to exceed the minimum 5 mil thickness.

Based on the average costs in Fig. 1, such a system will cost 43 c. per sq. ft. applied, as opposed to 32 c. for a more judiciously selected system, and will thus result in an increase of 34 percent in maintenance painting costs. "Build per coat," therefore, is an important consideration in purchasing and applying maintenance paints.

Without resorting to special application techniques, oleoresinous coatings normally range between 1 and 2 mils per coat; most synthetics, including vinyl, polystyrenes, epoxies, furane and phenolic maintenance paints, most chlorinated rubbers, and many synthetic rubbers will range between 4 to 11 mils per coat; whereas only a few bitumens, synthetic rubbers, and chlorinated rubbers will yield consistently higher than 2 mils per coat.

Since paint performance is improved by the use of specially formulated primers which are usually quite fluid and therefore of low build, the desired minimum 5 mil thickness can be obtained in the economical three coats only when the protective cover coats consistently yield 2½ mils per coat or greater.

Thus, it is profitable and possible to select a resistant paint system which will equal or exceed 5 mils total dry thickness in no more than three coats. Remember each additional coat required over three will increase maintenance painting costs 17 percent, with no compensating increase in service life.

Characteristics of System		System A	System B
Prime	Cost per gallon	-----	\$5.50
	Coverage per gallon	-----	250 sq. ft.
	Thickness per coat	-----	0.5 mils
Body	Cost per gallon	\$5.00	\$7.25
	Coverage per gallon	200 sq. ft./gal.	150 sq. ft.
	Thickness per coat	1 mil	3 mils
	Material cost per coat for prime	-----	2.2¢
	Material cost per coat for body	2.5¢	4.8¢
	Number of coats to build up 5 mils	5	3
	Paint thickness obtained	5 mils	6½ mils
Cost Per Square Foot			
Material		12.5¢	11.8¢
Surface preparation		15.0	15.0
Application labor		15.0	9.0
Scaffolding, misc.		0.5	0.5
Total direct applied cost		43.0¢	36.3¢

Fig. 6—System B at \$71 per gal. cheaper than system A at \$5.

Cost Applied vs. Cost per Gallon

Maintenance paints, through long past practice, are purchased after consideration of price and coverage per gallon, which by simple division yields a material cost per square foot per coat for cost comparisons. In the light of the preceding discussion this type of cost consideration is unsound and may often lead to the purchase of least economical materials.

As an example, consider the case of two widely used paint systems, each representative of a wide range of compositions of equivalent price and coverage.

System A (Fig. 6) is a synthetic system with an industrial list of \$5 per gal., an average coverage of 200 sq. ft. per gal., and yields with normal application a dry film thickness of 1 mil per coat. Although no primer is recommended with this system, the resulting conclusions will not be altered unless the substituted prime coat costs appreciably less than \$5 per gal., and gives substantially greater yields than 1 mil per coat. Such deviations are not likely with conventional primers.

System B is a synthetic rubber-base system specially formulated to yield three mils per coat with brush or spray application. Its cost is \$7.25 per gal. with a 150 sq. ft. per gal. coverage.

Using the average costs previously established with adjustments for the specific material costs, it may be seen from Fig. 6 that although System A has the lowest gallonage cost and the lowest square footage-per-coat cost, its applied cost to safe film thickness is 18 percent higher than the apparently more expensive System B. This is due to the fact that five coats of System A are required to attain the minimum thickness of 5 mils, whereas System B required only three coats. The labor cost of application more than compensates for the difference in material cost. Furthermore the 6½ mil thickness obtained with System B will add durability to this application to a degree not possessed by System A at 5 mils.

Surface preparation cost is taken at 15 c. per sq. ft. for both systems, scaffolding and miscellaneous at 0.5 c. per sq. ft. according to the average values in Fig. 1. Material cost per square foot runs slightly higher for system A than for system B: 12.5 c. per sq. ft. for system A to 11.8 c. per sq. ft. for system B.



Fig. 7—Time to touch-up. Wire brush OK for surface prep.



Fig. 8—Too late for touch-up. Needs complete surface prep.

FREQUENT TOUCH-UP CHEAPER THAN REPAINT

	Initial Application	Two Year Touch-Up	Three Year Repaint
Material	12.5 c./sq. ft.	2.5 c./sq. ft.	12.5 c./sq. ft.
Surface preparation	15.0	1.5	15.0
Application labor	15.0	3.0	15.0
Scaffolding misc.	0.5	0.5	0.5
Direct Total Costs:			
Per operation	43.0	7.5	43.0
Cost in 12 years	43.0	37.5	172.0
Cost in 12 years		80.5	172.0
Cost per year		6.7 c./sq. ft.	14.3 c./sq. ft.

Fig. 9—2-year touch-ups cost about half 3-year repaint jobs.

Inspection and Touch-Up

One of the largest single sources of maintenance painting cost reduction lies in adoption of a procedure, rather than material or application modification. A review of Fig. 1 shows that for the recommended three-coat system the costs of surface preparation is the largest single item of painting costs, approximating 50 percent of the applied cost. This expensive operation of cleaning and etching the base metal surface need not be repeated every time an area is painted, provided it is properly done initially and maintenance inspection and touch-up schedules established. These schedules require that each paint application be inspected at definite intervals after application, and local wire-brushing, spot priming, and cover coat renewal be done as soon as inspection shows the barest beginnings of localized failures (Fig. 7).

Once base metal is exposed, paint deterioration will greatly accelerate due to undercoating and lifting of the film edges by corrosion products. If the cleaned metal surface is always protected by a sound, continuous, protective paint film, paint life can be extended five or ten-fold. On the other hand, if a paint application is allowed to deteriorate until rust formation is thick and covers large

areas of the surface (Fig. 8), a complete surface preparation must be included in each paint renewal.

It is evident from Fig. 9 that with a system of periodic inspection and repair, the cost per year, based on a 12-yr. period, is 6.7 c. per sq. ft. This is 54 percent less than when a complete surface preparation and paint renewal operation is performed every three years. This table is calculated from previously cited cost coverages, coupled with the experience that for many common aggressive chem-industrial exposures, incipient deterioration will occur in two years, and irreparable destruction in three years. In the table, costs are deliberately selected to be safely on the high side in that it is assumed that up to 10 percent of the original painted area will require attention at each touch-up period, and the entire original area is over-coated. Such extensive repair is seldom required.

How Study Was Made

The comprehensive evaluation and standardization program for industrial maintenance painting which is the basis for this article was conducted in three of the company's chemical manufacturing plants. This provided three geographically divergent locations for exposure studies and permitted investigation of some 14 chem-industrial environments ranging from the relatively mild yard weathering stations to the aggressive action of moist hydrogen fluoride fumes. Included also were chlorine, hydrogen chloride, ammonia, acidic and alkaline sulphates, and caustic soda exposures. All of these exposures were in the presence of moisture—and in certain areas they were compounded by oxidizing conditions and the presence of hydrocarbon and alcohol vapors. The evaluation program is still being continued.

The performance of 62 maintenance paint formulations representing ten different basic types has been studied to date under actual plant exposure conditions. The comparative evaluations reported here are based on atmospheric or fume exposures: they do not relate to conditions of continual splash and spillage, or to extreme corrosive fume conditions. However, paint performance under these latter special conditions is recorded for the more promising materials and procedures in actual plant use. (Paints for these special conditions are economically confined to

the protection of costly or strategic equipment or structural members—so the cost and applications limitations restricting the general purpose painting systems no longer hold. Limitations for special-purpose use are defined only as the most simple, most economical method of obtaining the required protection.)

The 357 individual determinations upon which this article is based include exposures previously mentioned over both sand-blasted and corroded wire-brushed steel surfaces, and include performances of representative materials of oleoresinous, bitumen, wax, vinyl, furane, epoxi, phenolic, polystyrene, and synthetic and chlorinated rubber film-forming base. All exposures are actual plant exposures under production conditions and no artificial or simulated exposures are included.

EVALUATION METHODS

Early determinations were made by paint applications upon plant equipment and structures within each study environment, but it was soon found that direct performance comparisons between as many as twenty or more such "test patches" were unreliable due to differences in base surface characteristics and intensity of exposure from one patch location to another. Comparative determinations of paint performance on plant equipment and on standard KTA test panels¹ gave assurance that such panels would reliably predict performance on plant equipment and structures, and these panels were adopted for all elimination testing. Paint systems and procedures found of promise by these panel comparisons were then applied to plant equipment and structures for final performance study.

The KTA test panel and the test procedures involving its use were developed by Kenneth Tator Associates, which firm is assisting Pennsalt in this program. The panel is reproducibly constructed of SAE 1020 steel plate and bar channel to include all common structural surface configurations and defects commonly encountered on steel surfaces in industrial production use. Welds, both continuous and tack, are made with AWS E6010 rod using 25 percent penetration with normal spatter. Thus the material and techniques, as well as the surface irregularities, represent industrial structural practice.

Since surface and exposures are identical to those of the plant operating equipment and structures, no acceleration of paint deterioration may be expected. By observing paint performance over such points of early failure as sharp edges, welds, and projections, however, early indications of performance may be obtained. Also, acceleration may be obtained by locating the panel racks close to the source of deteriorating fumes or atmosphere.

By exercise of these two procedures, paint performances in aggressive chem-industrial atmospheres can be reliably classified within a 6-month exposure period. Obviously unsatisfactory systems can be eliminated on performance after 4 to 8-weeks' exposure and any system which shows no deterioration after 20-week's exposure has proven to give superior performance in actual plant use. All panel results used as the basis of this article have been on exposure for a minimum of 22 weeks; hence the quality of performance has been completely classified in all cases.

Exposure time indexes of performance vary considerably with aggressiveness of exposure but represent average relationship for the 14 environments under study. They also represent service over sand-blasted surfaces, which are the standard base surfaces for preliminary comparisons. Those systems which show promise over blasted surfaces are re-exposed on corroded, wire-brushed panels to determine their ability to maintain protection under this less-favorable condition (Figs. 10 & 11).

All of the results were obtained in chem-industrial exposures, but the principles demonstrated will also apply for less aggressive environments, although rates of deterioration undoubtedly will be slower.

No one paint type or formulation was resistant to all the environments studied, although many types had greater universality than others.

REFERENCES

1. J. B. Scott, "How to Protect Your Steel," *Chem. Eng.*, April 1951, p. 125.
2. J. B. Scott and Kenneth Tator, "More About Protecting Your Steel," *Chem. Eng.*, Sept. 1951, p. 167.
3. G. H. Young and G. W. Gerhardt, "Film Continuity of Synthetic Resin Coatings," *Ind. Eng. Chem.*, 23, No. 11, November 1927, p. 1277.
4. Kenneth Tator, "Cuts Paint Evaluation Time," *Chem. Eng.*, Oct. 1951, p. 140.

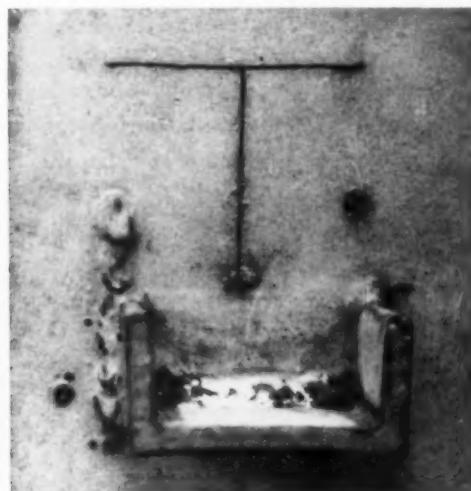
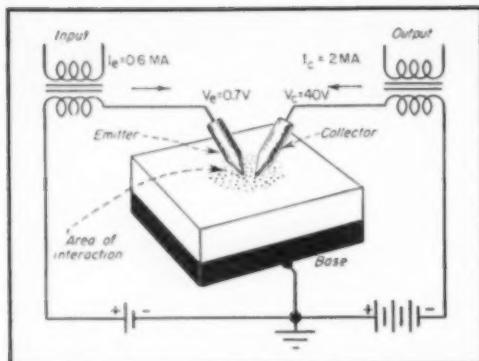


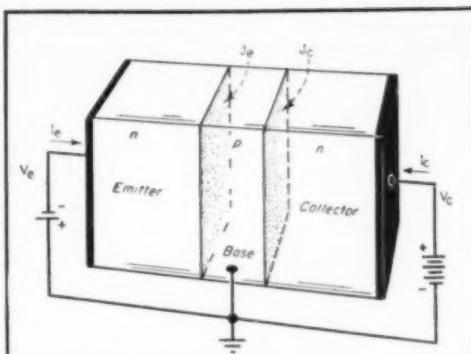
Fig. 10—Section of test panel showing points of early failure.



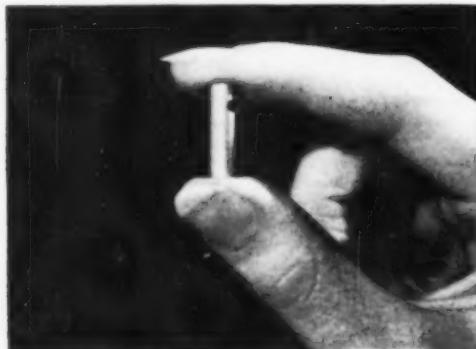
Fig. 11—Corroded panel for testing after wire-brushing.



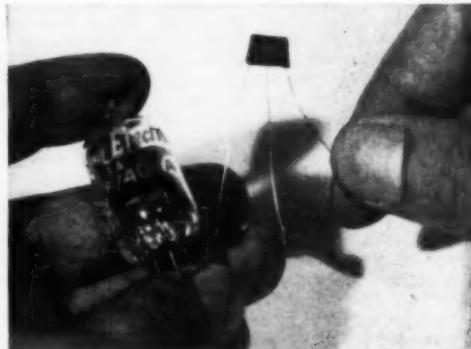
POINT-CONTACT transistor has probes touching Ge block.



JUNCTION transistor has different zones in single crystal bar.



POINT-CONTACT type is housed in cylinder like .22 shell.



JUNCTION transistor is far smaller than miniature vacuum tube.

What Can Transistors Do?

If you're a chemical engineer you'll want to know all about them because the electronics industry is rapidly going the way of the transistor, which means better process controls and even robot plants.

JOSEPH A. O'CONNOR

Transistors, tiny germanium crystal amplifiers no bigger than a kernel of corn, may spark a giant new industry rivaling the chemical industry in size. Electronics engineers and military men are agog at the possibilities of the new device, which may be one of the most important developments in electronics since the vacuum tube. Transistors can do most things a

vacuum tube can do; they can do some even better.

Besides their small size, transistors are compact and rugged, need no warm-up, require infinitesimal power, have no filament to burn out, and will last almost indefinitely. Together with new germanium rectifying devices, they are opening a new era for electronics. They will have a big future in the chemical process industries.

ROBOT PLANTS

Almost completely automatic chem-

ical plants are envisioned by General Electric experts, with routine decisions being made by transistorized electronic devices, which would carry out their own orders.

For the chemical process industries, transistors point to new control devices, according to General Electric, that will perform duties hitherto not entrusted to fragile electronic equipment. New germanium rectifiers will replace selenium and copper oxide rectifiers.

But first uses for transistors will

JOE O'CONNOR, CE's news editor, picks up transistor story after telling about germanium in April (p. 158).

come in electronic computers, the fabulous machines that "think," and in communications equipment and what former Defense Mobilizer Charles E. Wilson has repeatedly called "fantastic new weapons." These could be long-range guided missiles with transistorized computer circuits that would be compact and wouldn't burn out.

The Army Signal Corps has developed a radio-teletypewriter converter that uses transistors instead of vacuum tubes. It requires only one-hundredth of the current needed for equipment now in use, weighs only 10 lb. compared with 100 lb. The converter changes radio impulses to electrical current that operates a teletypewriter. It will bring printed messages much closer to the front lines.

The transistor will make possible direct long distance telephone dialing. The Bell System will use transistors in its telephone equipment this year. With transistors, it now becomes practical to build long-lived amplifiers for telephone cables at the bottom of the sea.

Transistorized electronic equipment will lighten the load on military and commercial planes, and take up less space. Moreover, the equipment will operate more dependably. A few years ago, tubes were found to be responsible for about half the failures in the electronic equipment of 750 commercial transports.

Other possibilities are tiny tubeless radios and hearing aids that will work a year without a change of batteries.

ELECTRONIC COMPUTERS

Since transistors don't heat up like vacuum tubes, electronic computers in which tubes are replaced by transistors can be built more compactly, requiring less air space for heat dissipation. A unit that once occupied a room might fit in the space of a desk. And the computers will suffer fewer "nervous breakdowns," will be able to do more thinking. In five months, 5,000 of the 18,000 tubes in a large digital computer were replaced; tube failures accounted for about 90 percent of the breakdowns.

Computing machines capable of running entire plants, according to General Electric, may be depended on for reliable, stable performance. Computers are being used more and more to solve difficult problems in thermodynamics, kinetics and other fields of chemical engineering.

HOLDS AND ELECTRONS

A triumph of quantum mechanics, the transistor confirms the theoretical concept of the positive hole and its

negative counterpart, the excess electron, in the modern theory of solids. It opens a new field of solid state physics, called transistor electronics, in which semiconductors are all important.

Semiconductors, such as germanium and silicon, are between conductors and insulators in their ability to carry current. The semiconductors of interest in transistor electronics are electronic rather than ionic conductors. In electronic conductors, the atoms stay in the same positions. They may lose or gain electrons during the conduction process, but the structure and chemical composition remain unaltered.

TRANSISTOR'S BIRTHPLACE

The transistor was invented in the Bell Telephone Laboratories at Murray Hill, N. J. Key investigations that brought the transistor to reality were carried out by Dr. John Bardeen and Dr. Walter H. Brattain. The research leading to the transistor was initiated and directed by Dr. William Shockley.

The point-contact transistor is but three and a half years old; it was first announced by Bell Labs in July 1948. Since then it has been greatly improved, and a radically new type, the junction transistor, has been invented by Dr. Shockley.

WHAT THEY LOOK LIKE

Essentially, the point-contact transistor consists of two hair-thin wires touching a tiny block of germanium to which is soldered a base contact. The entire apparatus is housed in a metal cylinder about the size of a .22 caliber shell.

The new junction transistor has no point contacts, which in the original transistor corresponded to the terminals of a vacuum tube. Instead, it consists of a tiny bar of germanium, treated so that it contains a thin electrically positive layer between two electrically negative ends—all within a single piece of metal.

It gets its name from the two "junctions" between the negative ends and the positive layer. It differs markedly from the point-contact type in which the contacts at the points play an essential role.

Compact and rugged, the junction transistor is imbedded in hard plastic. Wire leads to each of the three regions in the germanium are brought out of the plastic as "nigails." This gives a sturdy unit that withstands shock. Transistors have withstood mechanical shocks up to 20,000 times the force of gravity. The junction transistor occupies about 1/400 of a cubic inch—or about 1/50 the space occu-

pied by a typical subminiature vacuum tube.

SIMILAR TO VACUUM TUBE

Basically, transistors are three-element devices—crystal triodes. They correspond to the vacuum tube, having the equivalents of cathode, grid and plate. But unlike the tube, they require no glass envelope and don't have to be evacuated. With no filament to be heated to boil off electrons, they start up instantly. Since they consume little power and therefore dissipate almost no heat, cooling is no problem. As a result, transistorized electronic devices can be made far more compact.

THREAT TO TUBES

How big an impact will transistors have on the vacuum tube industry? At present a \$230 million a year business, it may eventually concentrate on high-frequency tubes and picture tubes for which germanium devices are not suitable substitutes. According to I. J. Kaar, manager of engineering for the Electronics Division of General Electric at Syracuse, N. Y., transistors and germanium rectifying devices are smaller, more efficient, cheaper to operate, longer lasting, and potentially less expensive than vacuum tubes. Thus they threaten the almost 40-year reign of the vacuum tube over the electronic industry.

LOW POWER CONSUMPTION

The new junction transistors are even more efficient than the point-contact type. They consume far less power than the point-contact device, which itself operates on less power than a flashlight bulb—about a thousandth of a watt. Their small size, too, is a great advantage.

When a vacuum tube is used to amplify a millionth of a watt signal, it consumes a full watt. This, according to Dr. Ralph Bown, vice president in charge of research at Bell Telephone Laboratories, is "about like sending a 12-car freight train, locomotive and all, to carry a pound of butter." The new junction transistor, unlike any previous amplifier, can operate on about a millionth of a watt, just enough to carry the signal without waste.

OPERATE ON FLEA POWER

Perhaps the best example of this amazingly small power consumption in the junction transistor is an audio oscillator that operates with an input power of only 0.08 millionths of a watt, consisting of 50 millivolts at 1.5 microamperes. This is really a "flea-

power" device. Assuming a dog flea weighs one milligram and jumps to a height of 50 centimeters, R. L. Wallace, Jr., of Bell Labs calculates that the flea, in making one such jump every minute, uses about the same energy it takes to keep the oscillator running.

EFFICIENCY

Transistors are highly efficient. For junction transistors, what electrical engineers call Class A efficiencies of 48 or 49 of a possible 50 percent can be realized. Efficiencies for Class B and C operation are correspondingly high, reaching as much as 98 percent. For point-contact transistors, Class A efficiencies of 50 percent are possible, and Class C efficiencies of 90 percent.

Gain or amplification per stage is on a par with vacuum tubes. Bell Labs has built a two-stage transistor amplifier, complete with resistors and condensers, that is potted in a cylinder of plastic as big as a $\frac{3}{4}$ -in. section from a fountain pen barrel. It can amplify a whisper to an ear-splitting roar.

Transistors may last 10 years or longer. From tests, a useful life of 70,000 hr. has been calculated for a point-contact transistor, and a life of 90,000 hr. for the junction type.

SHORTCOMINGS

Transistors still seem to be noisier than vacuum tubes. However, the junction transistor is 1,000 times less noisy than the point-contact type. The noise problem becomes greater at higher frequencies.

Like a vacuum tube, a transistor has an upper frequency limit caused by the capacities between the elements. The principal frequency limitation in a transistor, however, is due to the slow transit time of the electrons and holes in the semiconductor. Upper frequency limit for junction units is 3 to 5 megacycles, while point-contact transistors have operated at up to 70 megacycles. This compares with frequencies of 60,000 megacycles for vacuum tubes.

Because thermal agitation affects the amplifying ability of a semi-conductor and because at higher temperatures transistors get more noisy, germanium transistors are currently limited to about 70 deg. C. compared with about 500 deg. C. for vacuum tubes.

At present, transistors are low-power devices. Except for laboratory units, they are generally limited to handling power outputs up to 2 watts. But there appears to be no fundamental bar to handling power levels equal to that of any receiver power tube. As a result, radio receivers with normal

sensitivity and power output can now be built completely without vacuum tubes.

OTHER GERMANIUM DEVICES

Transistors aren't the only electronic devices using germanium crystals. Miniature two-element rectifying units, called germanium diodes, are now being produced at the rate of 7 or 8 million units per year. Bell Telephone Laboratories has come up with a new electric eye—smaller, sturdier and possibly cheaper than present photoelectric cells. It's called the phototransistor. Sylvania Electric Products Inc. makes a similar device, the photodiode. Both the phototransistor and the photodiode are activated by light.

RECTIFIERS

Germanium rectifiers for industrial use can operate at current densities up to 1,000 times greater than present selenium and copper oxide rectifiers. General Electric Co. considers the germanium rectifier the best ever. GE is now producing rectifiers with single-phase half-wave ratings of 12 v. at 0.4 amp., 21 v. at 0.4 amp., 27 v. at 0.4 amp., and 6 v. at 6 amp. Physically, these new rectifiers occupy about 10 cu. in. per kw. of output capacity, compared with about 350 cu. in. per kw. for selenium rectifiers. Operation tests of the new rectifiers at the rated voltage over a 5,000-hr. period indicate no change in forward resistance and reverse leakage.

While these rectifiers are of limited size, it's known that work is being done on rectifiers for much heavier currents—up to 300 amp. Germanium rectifiers are still in diapers.

PURE GERMANIUM ESSENTIAL

Makers of electronic devices get their germanium from Eagle-Picher Co., the principal producer. Most buy germanium dioxide and reduce it themselves. The dioxide is packed into graphite boats and reduced in an electric furnace in a current of hydrogen at about 650 deg. C., after which it's melted in an inert atmosphere in the same furnace at 1,000 deg. C. On cooling, the germanium ingots take the shape of the graphite boats.

Next, the germanium is purified by fractional crystallization. The metal is melted in a graphite boat in a horizontal tube furnace at close to 1,000 deg. C. This is done either in an inert atmosphere or under vacuum. When the induction heating coil outside the tube furnace is backed off, the germanium cools slowly from one end to the other at a rate of 1 to 8 in. per hr. This segregates impurities in the metal since those with a greater solu-

bility in the solid phase solidify out first, while those more soluble in the liquid phase remain in the liquid and collect at the opposite end of the ingot.

If the germanium metal isn't pure enough, the ends can be broken off, several center sections melted up together and recrystallized. These recrystallizations are repeated until the required purity is obtained. The process, according to J. P. Jordan of General Electric's electronics laboratory at Syracuse, N. Y., is about 90 percent efficient, it being necessary to discard about 10 percent of the germanium containing the concentrated impurities.

PULLING SINGLE CRYSTAL METAL

Germanium purified by fractional crystallization is multi-crystalline. It can be used in point-contact transistors, but it took a new metallurgical technique to produce the single crystal germanium needed in junction transistors.

Germanium is melted in a carbon crucible by resistance heating and held at about 960 deg. C., a few degrees above the melting point. Single crystal germanium can be drawn from the melt by immersing the end of a single crystal seed and slowly withdrawing it. The temperature of the melt and the rate of withdrawal determine the diameter of the single crystal germanium so produced. This process can be carried out under vacuum or in an inert atmosphere of helium or argon.

ADDING IMPURITIES

Doping of the melt with tin and other impurities while pulling single crystal germanium makes possible carefully controlled addition of impurity elements that change the conductivity of germanium. Thus junctions between electrically positive and electrically negative zones can be created in the same piece of germanium. The germanium absorbs arsenic, an impurity element, from the tin.

Other methods for getting impurities into the germanium are: pressure (around 200,000 psi.), which creates a *p*-zone in *n*-germanium; heating to over 500 deg. C. and quenching, which transforms *n*-germanium into *p*-type; and diffusion of an impurity metal of the opposite type into the lattice by heat and allowing action. The first two are more important in point-contact devices. General Electric has developed a new diffusion-type junction transistor, which is now being readied for mass production.

Today, transistors cost \$15 to \$20.
(Continued on p. 370)

Benzene From Petroleum—At What Price?

ROGER WILLIAMS, JR.

Most chemical companies rightly consider the petroleum industry a vast storehouse of raw materials for producing organic chemicals. In considering raw materials from petroleum, however, chemical companies should recognize some of the economic factors which tend to make chemicals from petroleum, or some of them, relatively high priced. Take benzene for example.

In a recent article (*Production of Aromatics from Natural Gas Liquids*, *Oil & Gas Journal*, Aug. 9, 1951, p. 84), C. R. Williams and R. E. Southerland have presented an analysis of the cost of producing benzene from a debutanized natural gasoline by the platforming process. Unfortunately for the average chemical engineer, the analysis is carried out in normal methods used by petroleum economists and the result is presented in terms which are unfamiliar to chemical company engineers and economists—the profit result is given in payout-time before taxes and depreciation and with no allowance for working capital, but after an allowance for "interest on average balance."

To make Williams and Southerland's analysis more readily understandable to chemical engineers in the chemical industry, we have converted their figures to the accounting methods normally used by one of the large chemical companies, only condensing some of the individual items to avoid revealing the individual estimating factors used. Williams and Southerland's analysis and the revised figures are shown in the Tables I and 2.

The revised figures point out some interesting facts.

First of all, the accounting methods used by the petroleum companies have a tremendous effect on the price of the finished product. In the benzene case considered here, over \$8,000,000 worth of petroleum products must be handled through the unit, and yet the fuel charge against benzene is only \$224,000. Therefore, only a small change or error in figuring the value of the feed and the main, gasoline product from the Platformer can have a tremendous effect on the charge against benzene. If the value of the

feed is figured only 1 percent low, and the product gasoline 1 percent high, the figure of \$224,000 jumps to \$1,845,000—a 720 percent increase!

The net result is that the petroleum companies must carefully evaluate the value of their intermediate products. (Continued on p. 378)

PROFITABILITY of Benzene Production by Platforming—Table I

		Dollars per Oper. Day
Credits		
5,200 bbl. per stream day, 10-lb. R.V.p. blending stock at 11.0 c. per gal.* (2.4 cc. per gal. TEL)	\$24,301.20	
300 bbl. per stream day benzene at 45 c. per gal.	5,670.00	
Fuel-gas make— 27.3×10^4 Btu. per hour at 11 c. per MM Btu.	72.00	
		\$30,043.20
Debits		
5,200 bbl. per stream day debutanized light natural gasoline at 10.30 c. per gal.† (unloaded)	\$24,658.20	
Direct operating costs for Platforming:		
Supervision—est. at 25 percent of labor	\$24.00	
Operating labor—2 men per shift at \$2 per hr.	96.00	
Water—12.5 c. per gal. reactor feed	125.00	
Maintenance—estimated	90.00	
Royalty—1,000 bbl. per stream day at 7 c. per bbl. + 1.0 c. per gal. benzene	196.00	
Taxes and insurance—estimated at 2.5 percent	73.00	
Interest—average balance at 4.0 percent	70.00	
Solvent for extraction—estimated	18.00	
Utilities:		
Fuel— 5×10^4 Btu. per hr. at 11 c. per MM Btu.	54.12	
Water—770 gpm. at 1 c. per 1,000 gal.	11.09	
Steam—2,400 lb. per hr. at 25 c. per 1,000 lb.	14.40	
Power—130 kw. at 1 c. per kWh.	31.20	
TEL costs at 0.25 c. per cc.— $5,200 \times 42 \times 2.4 \times 0.0025$	802.81	
		1,325.52
		\$26,786.53
Net profit before depreciation		\$3,256.67
Platformer Extraction	\$675,000 335,000	
Payout time on	\$1,010,000	0.9 years

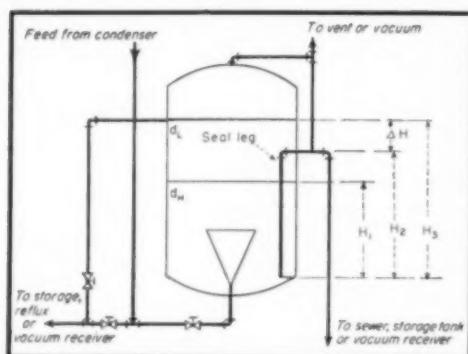
* Average of lows for 86 research octane gasoline for Gulf Coast—cargoes, domestic and export, all ports for National Petroleum News for 1951.

† Average of lows for 82 research octane gasoline after deducting cost of TEL (2.8 cc. per gallon).

COSTS Calculated on a Chemical Industry Basis—Table II

		(Production: 4,200,000 gallons per year)	Quantity	Unit Price	Dollars Per Year	Dollars Per Gallon
Ingredients						
Debutanized light natural gasoline, gal.	79,700,000	0.1030	\$2,151,000			
Tetraethyl Lead, cc.	117,000,000	0.0025	443,000			
Catalyst		Estimated		42,000		
Solvent		Estimated		6,000		
Total ingredient cost				8,706,000		2.07
Operating cost						
Operating labor, man-hr.	35,000	2.0000	70,000			
Maintenance		Estimated		38,000		
Water, m-gal	270,000	0.0100	2,700,000			
Steam, m-lb	19,000	0.2500	4,750			
Electric, kwh	1,040,000	0.0100	10,400,000			
Fuel gas, MM-Btu.	164,000	0.1100	18,000			
Depreciation		7% investment		71,000		
Taxes & insurance		Estimated		2,000		
Overhead		Estimated		76,000		
Royalty		Estimated		65,000		
Total operating cost				392,000		0.10
Total gross bulk cost				9,098,000		2.17
Byproduct credits						
Blending stock, gal	73,600,000	0.1100	\$8,100,000			
Fuel gas, MM-Btu.	218,000	0.1100	24,000			
Total byproduct credit				\$8,124,000		1.94
Total net bulk cost				974,000		0.23
Other expenses						
Selling expenses		Estimated		13,000		
Administration & Mktg.		Estimated		6,000		
Total cost of sales				993,000		0.24

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Self Acting System Simplifies Decanting Problems

STANLEY YOKELL, Chemical Engineer, Industrial Process Engineers, Newark, N. J.

★ March Contest Prize Winner

A common problem in chemical processing is the continuous decanting of two-phase distillates. Ordinarily, settling tanks, which require periodic attention are used. Above is a schematic diagram of a self acting decanter. It operates by difference of density of the phases. Advantages are cheapness, simplicity of design and construction, and safety and simplicity of operation.

The decanter consists of a tank with internal bottom entering, funnel shaped inlet. Internal and external piping are arranged as shown. Overflow lines are sized so that no throttling of effluents can take place. A simple relationship governing the operation and design of the decanter can be derived as follows:

d_H = density of more dense phase

d_L = density of less dense phase

R = d_H/d_L

ΔH = Height of overflow of less dense phase above seal leg

H_1 = Height of phase interface

H_2 = Height of seal leg

By inspection the relationship may be written:

$$\Delta H = (H_2 - H_1) (R - 1)$$

Knowing the densities of the phases and bearing in mind their possible variation with temperature, the correct proportions can be selected. Funnel outlet to inlet diameter ratio is chosen to minimize entrance effects of mixed dis-

tillate stream. The location of the funnel mouth depends upon the ease of separation of the phases. Where separation is rapid it is best located at approximately $\frac{1}{2}H_1$. Interface height is set to give a safe seal of less valuable material if surges from the condenser upset the balance of the decanter. By the installation of a few accessories the system can be made foolproof, suitable for vacuum operation and arranged to pipe either or both phases to storage or recovery.

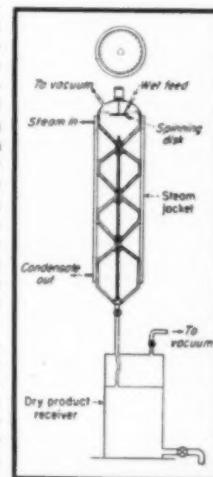
Distillation Tower Becomes Vacuum Dryer For Viscous Liquids

ANTHONY P. MASSA, Chemical Process Engineer, H. K. Ferguson Co., New York, N. Y.

Old 8-in. or 12-in. diameter steel distillation towers can be used as vacuum drying towers by removing the bubble cap plates and inserting a rod containing conical fins. These fins are welded in such a manner as to form a long path of fall for any liquid entering the top of the column. Alternate fins are welded to the rod by means of "dog-ears" so that the flow of liquid alternates from the sides of the column to the central rod and then back to the sides of the column.

If this column is then provided with a steam jacket, the assembly can be used for drying plasticizers and other heavy, non-volatile liquids by operating the tower under vacuum. The wet liquid is allowed to enter the column at the top and is distributed around the inside shell of the column by means of a swiftly spinning disk. The tower can now be classified as a falling film type of vacuum dryer.

The value of such a dryer lies in the principle of lengthening of the drying path by means of the cascade arrangement of the fin-plates resulting in 50 percent or more greater drying surface per given height of tower. The heat transfer from the steam jacket is good because of the good



★ April Contest Prize Winner

"How to Apply Compound Interest Relations in Engineering Cost Studies."

A prize of \$50 in cash will be awarded to H. E. Schweyer, professor of chemical engineering, University of Florida, Gainesville, Fla. Dr. Schweyer's article will appear in the June issue.

\$50 PRIZE FOR A GOOD IDEA—Until further notice the Editors of Chemical Engineering, will award \$50 cash each

month to the author of the best short article received that month and accepted for publication in the Plant Notebook. Each month's winner will be announced the following month and published the second following month.

\$100 ANNUAL PRIZE—At the end of each year the monthly winners will be rejudged to determine the year's best Plant Notebook article, which will then be awarded an additional \$100 prize.

HOW TO ENTER CONTEST—Any reader of Chemical Engineering, other than

a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Articles which are acceptable but are not winners will be published at regular space rates (\$10 minimum).

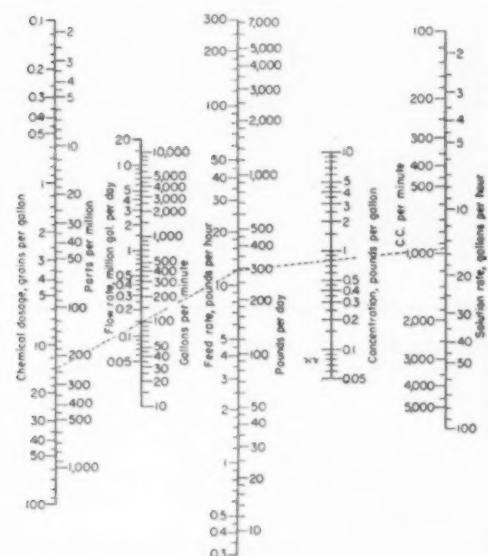
Articles may deal with plant or production "kinks," or novel means of presenting useful data, which will interest chemical engineers. Address Plant Notebook Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y.

thermal conductivity of the fin-plates, the system acting as a modified fin-tube heat exchanger.

This dryer is useful where limited space is available and the materials to be dried are highly viscous. A dryer of this type takes up less floor space than a conventional spray-dryer handling the same through-put. The initial cost of a falling-film tower dryer is much less than that of a steam-jacketed intensive mixer or rotary dryer operating under vacuum.

An additional advantage of a vacuum drying tower is that the operation is continuous and little, if any, work is required in loading and unloading operations.

If the oils or materials to be dried are affected by temperatures above 100 deg. C., then hot water may be used as the heating medium during the drying operation.



Chemical Dosage Nomograph Speeds Treating Computations

A. I. BARRY, F. S. Gibbs, Inc., Newton Lower Falls, Mass.

This nomograph was made to permit a rapid calculation of chemical feed requirements for treating a known volume of water with a given dosage of a chemical. It should be applicable in municipal water treatment and industrial waste treatment plants; as well as allied industries.

Except for the concentration axis, two scales have been used on each axis. With double scales the more convenient scale for the particular application may be selected. The double scales also serve as handy conversion table for several factors.

The use of the nomograph is simple, as is shown by the example. At a dosage of 14 grains per gal. and a flow rate of 100 gpm., a line through these two points in the nomograph will intersect the feed rate axis at a value of 12 lb. per hr.; the chemical feed rate using a dry feeder. For adding a solution of the chemical, select the most suitable solution concentration and rate by means of a straight line extended from the feed rate axis to the solu-

tion rate axis. For example: to feed 12 lb. per hr. of a chemical with a solution made up with 0.8 lb. of chemical per gallon of solution, the solution rate will be 15 gal. per hr.

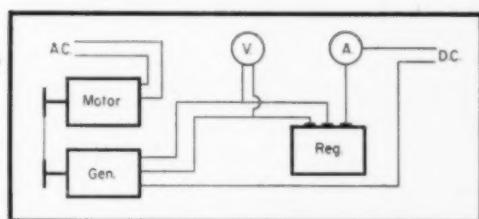
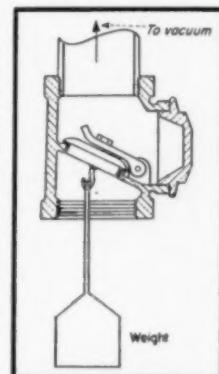
Vacuum Controller

G. L. FOEHRINGER, Chemical Engineer, A. E. Staley Mfg. Co., Decatur, Ill.

On several occasions I have used an improvised vacuum controller. The design is not original but is intriguingly simple. The controller consists of a gate type check valve mounted between the source of vacuum and the evacuated equipment in such a way as to permit atmosphere air to flow into the vacuum system. A weight attached to the valve gate tends to hold it closed. This arrangement will limit the absolute pressure in the system to a value P in the equation: $P = \text{atmospheric pressure} - (W/A)$.

Here W = the weight attached to the gate and A = the cross sectional area of the valve seat opening.

The exact arrangement is illustrated by the accompanying sketch. This type of controller can be easily fabricated by either brazing a hook to the valve gate or by drilling and tapping the gate to receive a bolt. The desired weight can, in turn, be fastened to the hook or bolt. It is usually easier to determine the weight needed by trial and error rather than to calculate it from the equation. The improvised controller has proved to be very reliable.



A Source of Direct Current For Electrolytic Experiments

ALLEN J. FRITSCHE, Chemical Engineer, Sinclair and Valentine Co., Ridgway, Pa.

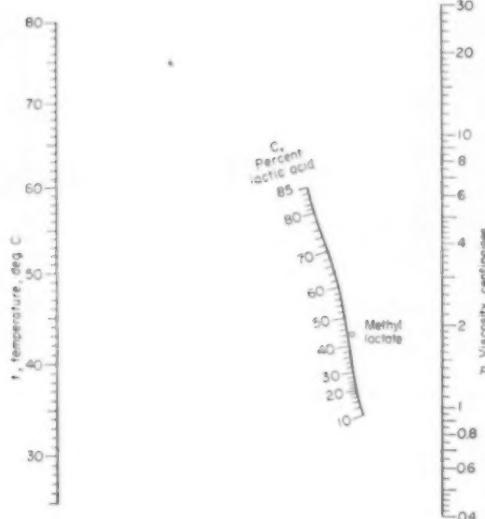
A short time ago we needed a source of direct current for electrolytic experiments in our laboratory. We used the following items and connected them as shown in the accompanying diagram: (1) automobile generator, (2) automobile voltage regulator, (3) 1/2 hp. motor, (4) ammeter, (5) voltmeter.

Although this method is somewhat limited as to the voltage and amperage that is obtainable, it was sufficient for our particular experiments.

By adjusting the regulator, we could obtain a range

of voltage from 4 to 9 v. Our limit of amperage was 28 amp., which was the upper limit of the regulator. The amperage was not essential as we were interested mainly in current density and we obtained the optimum working conditions by selecting the correct sizes of the anode and the cathode.

The items used to produce the direct current were not expensive and were easy to obtain.



Nomograph for Viscosity of Aqueous Lactic Acid Solutions

D. S. DAVIS, Professor of Chemical Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

Recent data on the viscosity of aqueous solutions of lactic acid were presented by Troup, Aspy and Schrotz in tabular form (*Ind. Eng. Chem.*, **43**, 1142, 1951). Logarithm of viscosity η was plotted against the logarithm of the absolute temperature T for concentrations of 9.16, 24.35, 45.48, 64.59, 75.33, and 85.32 percent of lactic acid, and an equation of the form of

$$\log \eta = a - b \log T$$

where a and b depend on the concentration of lactic acid. Since the data are of evident value in the design of lactic acid plants, further correlation was effected by relating a and b to the concentration C in accordance with the equations

$$\log a = h + k C$$

$$\text{and } \log b = m + n C$$

so that the final equation becomes

$$\log \eta = 10^h + 10^k C - (10^m + 10^n C) \log T$$

and is the basis for the accompanying line coordinate chart.

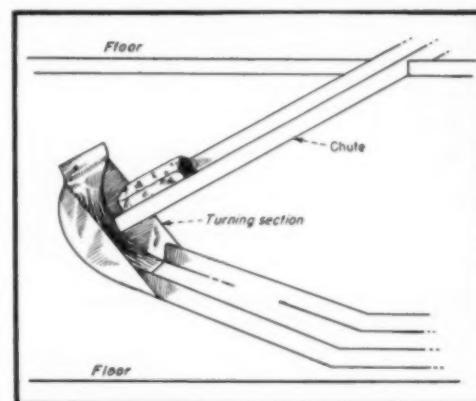
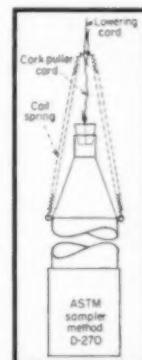
The use of the chart, which also covers methyl lactate, is illustrated as follows: What is the viscosity of a 66 percent aqueous solution of lactic acid at 37 deg. C? Connect 37 on the T scale with 66 on the C scale and produce the line to the η scale where the desired value is read as 5.0 centipoises.

To what temperature must methyl lactate be heated so that its viscosity is 2 centipoises? Connect 2 on the η scale with the point labeled "methyl lactate" and produce the line to the T scale where the temperature is found to be 40 deg. C.

Improved Tank Sampling Device

E. M. MILNER, Chemical Engineer, Dixie Pine Products Co., Hattiesburg, Miss.

An improvement can be made on the weighted beaker type tank sampler described in ASTM Method D-270 by removing the wire handle and replacing it with a piece of brass screen-door spring. The lowering cord or wire is then attached as shown in the drawing, so that there is no tension on the cork stopper while the beaker is being lowered to the sampling depth. When this depth is reached the cord is given the usual quick jerk, and the weight of the beaker or bottle stretches the spring enough to pull out the stopper and let the sample enter. Rigging the sampler in this manner will prevent its opening prematurely.



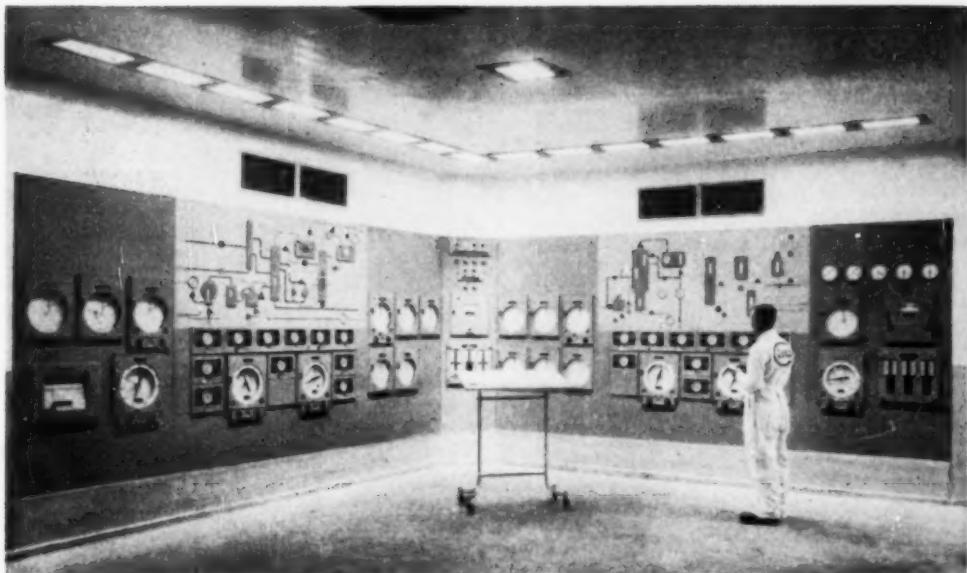
Floor to Floor Conveyor

IRA A. BUTCHER, Engineer, Cincinnati, Ohio

It is sometimes desirable to lower materials from one floor to another. A spiral conveyor is normally used for the job, but may not be available.

If the material is in boxes or bags of uniform size, lowering can be accomplished with straight chutes if they are built as indicated in the accompanying sketch. When a chute is steep enough for a package to slide, it will accelerate. And if it bumps another package it may split one or both of the containers.

By making the individual chutes short, impact can be kept low. The trick is to make the turning section of the chute as small as possible, yet sufficiently large to pass the package and turn it over at each change in direction.



Graphic panel for fluid cat cracking and gas recovery in a refinery (Photo from Minneapolis-Honeywell Regulator Co.).

PROCESS INSTRUMENTATION

As the instrumentation of chemical engineering processes comes close to its maturity as a science rather than an art, Chemical Engineering brings its readers the third in its 23-year series of process instrumentation reports.

CHEMICAL ENGINEERING REPORT—MAY 1952

ONCE again this magazine brings its chemical engineering readers a comprehensive report on the instrumentation of chemical engineering processes. It is with a special feeling of close association with this developing science that we do so. This is true because our editorial efforts have been with it almost from the start—at least, from the start of its formal literature. It is true, too, because industrial instrumentation as such is virtually synonymous with process instrumentation. Much of the instrument industry's development has come about in close association with the process industries, or at the actual instigation of process men. More than a

few of today's instruments were the development of process men, later turned over to instrument makers for manufacture.

The present seems a particularly appropriate time for this report. A dozen years of electronic instrumentation has now firmly established this method. Pneumatic instrumentation has now completed another spurt of progress to keep pace with the demands for ever more exacting control. Only now is a new kind of automatic instrumentation definitely arriving—instrumentation for end-point analysis, which permits connecting quality criteria of the product back into the control loop. Finally, now more than ever before,

there is recognition that instruments are actually a part of the process. New techniques, such as the frequency response method, are on the verge of putting this recognition into practice.

To our authors, and to many others both in and outside the instrument industry, we are deeply indebted for assistance both in planning and in executing this report. We wish too to acknowledge the excellent cooperation of many more in the industry who supplied much of the information used as the basis of the 16-page folded chart of instrument elements which you will find inside the front cover of this issue.

THEODORE R. OLIVE
CECIL H. CHILTON

New Tools for the Process Engineer

Many recent developments, known and appreciated only by instrumentation specialists, can be powerful tools in the development and design of processes.

D. M. CONSIDINE

The greatest trend evidenced in industrial instrumentation during the past decade is a slow but steady transformation of this important field of endeavor from an art to an engineering science. Although instruments and controls, viewed as individual products, have always represented the results of much engineering and scientific skill—often the acme in sensitivity and precision—the application of these tools to the process industries has largely been an art, or, perhaps better termed, an empirical technology.

To change from empiricism to mathematical science is not easy, nor does the process occur overnight. Progress made in this direction by industrial instrumentation since World War II has been very encouraging, even though many of the fundamental changes in the thinking and approaches to process measurements and control may at the present appear haphazard and confusing.

In this article, part of the growing pattern is presented. An attempt has been made to present the highlights in the major areas of instrumentation. Because of the marked transition now underway, it is safe to predict that industrial instrumentation, when it is again reviewed in *Chemical Engineering* some five or ten years hence, will show radical departures from present practices.

ADVANCES IN THE PROFESSION

The instrument engineer has grown much in stature during the past decade.

Douglas M. Considine is manager of market extension for the Industrial Division of Minneapolis-Honeywell Regulator Co., Philadelphia. In addition to numerous other publications (including several for this magazine), he is author of the book, "Industrial Weighing," and is editor of the encyclopedic "Instrumentation and Control Handbook," which will be published in 1953.

A 1937 chemical engineering graduate of Case Institute of Technology, Mr. Considine joined Honeywell (Brown Instruments) in 1941, after varied experience with two large process engineering and consulting firms.

ade. The matter of specifying, installing and maintaining instruments and controls is now recognized by management as an important function in practically all large processing plants—and in many small enterprises too. Annual expenditures for instruments by many large companies run into millions of dollars. In the process industries, control equipment will run from 2 to 15 percent of the total plant cost. To protect investments of this magnitude, staffs of skilled men are required.

An organization dedicated to instrumentation, the Instrument Society of America, was formed on a national basis in 1945. This group has done much to foster the exchange of technical information and to raise the standards of recognition for all whose daily work is concerned with instrumentation.

The A.S.M.E., through its Industrial Instruments and Regulators Division, contributed a much needed glossary of automatic control terms in 1946. This glossary has done much to sharpen the comprehension of a rather complex subject. Much additional work remains to be done, especially in the fields of measurements and servomechanisms.

Other professional societies have shown an increasing interest in instrumentation. The A.A.S. has contributed much with its annual conferences on the subject. The Scientific Apparatus Makers Association has done much to establish and encourage materials and dimensional standards in instrument components.

One of the great needs facing industry and the instrument profession is that of training engineers in sufficient numbers. Several engineering schools have established courses in the subject during the last few years, as exemplified by outstanding curricula offered by Case Institute of Technology and Purdue University. Texas A. and M. has conducted excellent annual symposia on instrumentation for the process industries since 1946. The time has long passed when the subject can be covered in one or two lectures crowded into a chemical or mechanical undergraduate engineering course.

NEW APPROACHES TO AUTOMATIC CONTROL

Fundamental problems of automatic process control have remained the same since controllers were first applied to industrial processes. Long before World War II, users and manufacturers of instruments alike talked of the "closed loop" of the process and controller and the design requirements of each which affected the quality of control. But methods of analyzing control problems were still too cumbersome and impractical to supply readily usable data which could lead the way toward the ideal goal, namely: to design instruments and apply them in systems in the best possible way, as well as to design processes in such a manner as to take full advantage of automatic control.

Early in World War II, top-flight mathematicians and engineers conducted much secret work in the field of servomechanisms. Such a system might be used, for example, to position an anti-aircraft gun through a computer which received data from a radar tracking system. The control problem in this system involved extremely accurate positioning of the gun in the face of such factors as the large inertia of the gun and the high speed of the aircraft. Some method of analysis was required so that accurate performance standards for the system components could be established.

In tackling the servomechanism problem, workers appropriated techniques from communications engineers who had studied similar problems in electrical networks and feedback amplifiers. Thus were developed "servomechanism techniques" for the solution of component design problems and analysis of over-all system performance.

Also during the war, work on the atomic bomb brought together a wealth of scientific knowledge from a wide variety of fields. Because of the extremely hazardous nature of the process, the tremendous volumes of materials processed, and other critical factors, robotization of the processes was mandatory. Groups of process control engineers, manufacturers of industrial instruments, and servomechan-

ism engineers joined together to tackle these control problems; from this union was born the important concept of applying servomechanism techniques to process control problems.

Out of the increased use of controllers during the war emerged advances in both theory and application. Because instrument designs were frozen, more attention was focused on proper methods of applying the controls to the process. Perhaps the most important trend started during the war was the development of the centralized control board, in contrast to previously spotty and scattered instrumentation. With its advantages in process supervision, however, came certain disadvantages in operation which led to radical postwar changes in controller designs.

CONSOLIDATION OF NEW THEORIES

At the end of World War II, many of the scientists and engineers engaged in control problems for the military returned to private business and the universities. It was natural that many were inclined to "spread the gospel" by the publication of textbooks. Others felt equally strongly the need for advanced courses on control theory in the universities. Control engineers in industry—both users and instrument manufacturers—gained a glimpse of the promise these new control theories offered. In addition, many young engineers schooled in these new techniques found places in industry.

Electric and electronic analogs began to be more widely used for the study of control problems. They permitted engineers to simulate process characteristics in the laboratory and learn more about the relationships between such characteristics and controlled design. Each variable factor in the control loop could be altered by a known, measurable amount so that its relative effect on the quality of control could be carefully studied.

During this period instrument design work was intensified. Projects curtailed during the war and experience from the wide application of controls during the war created a large backlog in instrument research and development laboratories. Moreover, designers had an ideal opportunity to start from scratch and develop completely new unitized control systems, with each component designed to complement the other components.

SERVOMECHANISM TECHNIQUES ADOPTED

When control engineers saw the exact analogy between industrial process control systems and servomechan-

NEW TOOLS FOR THE PROCESS ENGINEER Page 162

By Douglas M. Considerine

Analyzes present trends and projects them into the future; reviews recent developments in measuring elements and instruments.

GUIDE TO PROCESS INSTRUMENT ELEMENTS Chart

16-page folded chart inside front cover

Tabulates, illustrates principles, range, accuracy and uses of measuring systems and other instrument elements.

NEW TOOLS FOR THE INSTRUMENT ENGINEER Page 173

By R. E. Clarridge and W. J. Berk

How signature curves and frequency response analysis help application of instruments to processes.

PROCESS CONTROL BY END-POINT ANALYSIS Page 180

By W. A. Patterson and J. M. Devine

Describes the principles and applications of instruments which measure, either specifically or inferentially, the composition of process streams.

INSTRUMENTATION PAYS ITS OWN WAY Page 189

By F. H. Trapnell, J. Johnston, Jr. and W. A. Crawford

Investment in instruments justified on the basis of reduced costs and many less tangible benefits.

A CRITICAL LOOK AT GRAPHIC PANELS Page 193

By Wesley T. Dorheimer

Advantages and disadvantages, definition and classification, review and forecast of an important instrumentation development.

INSTRUMENTS: EQUIPMENT, NOT ACCESSORIES Page 197

By Edmund D. Hoigler

Shows how instruments can and must be considered as an integral part of process equipment.

PUSH-BUTTON PLANTS: WHEN AND HOW? Page 202

By George A. Hell, Jr.

Defines the fully automatic plant in terms of instruments and techniques now available and estimates its impact.

isms, they began to evaluate servomechanism techniques and found that these techniques offered the following primary benefits:

1. They permit study of a going process for the purpose of determining the best attainable operation and the necessary characteristics of a control system to provide this operation.
2. For more complex processes, they offer the only practicable means of making such studies.
3. With data to be accumulated in the future on going processes, they promise a means of designing processes to make optimum use of automatic controls with a consequent decrease of plant investment and operating costs.
4. They permit the designer of processes or instruments to express performance of components of a control system in numbers which can be added together to give a criterion of over-all system performance.
5. They make potentially available, to a high degree, all the advantages of automatic process control—increased production rates, higher quality product, fewer rejects, safer operation, savings in consumption of fuel and raw materials, etc.

GRAPHIC PANELS MUSHROOM FORTH

Mention was made previously of the limitations of large centralized control boards. One limitation was

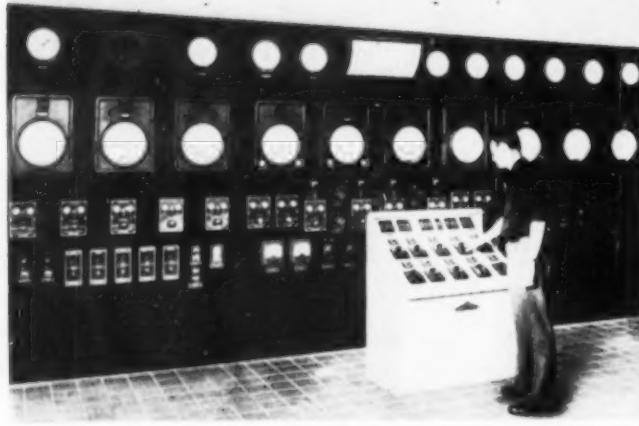
the difficulty operators had in gaining an over-all picture of process operations from the rows of similarly appearing instruments along a large panelboard. Training of new operators on such boards was a serious problem. Furthermore, the size of panelboards and the building necessary to house them became prohibitively large.

To overcome size limitations and improve process supervision, instrument engineers developed the idea of using a flow diagram of the process on the panelboard with smaller instruments mounted directly on the flow lines at points where measurement and control are actually being effected in the process. Size of the board was reduced appreciably and operator training time was cut down considerably.

Today, although the graphic panel idea is neither universally accepted nor always logically employed, it is definitely established in many plants. Oil refineries are the largest users, but paper mills, steel plants, and others are enjoying the advantages of graphic panels in their operations. (For a more complete treatment of this subject, see p. 193.)

NEW CONTROLLER COMPONENTS

Another disadvantage of central control panels was the introduction of an appreciable transmission lag be-



CONSOLE PANEL, using miniature instruments, tells the operator as much about the process as the larger conventional panel board.

tween the measuring or controlling element at the process and the indicator or recorder-controller on the panelboard. Such lags were due to the almost universal use of pneumatic transmission of measured variables and pneumatic control.

The logical answer to this problem was the location of the controller at the process, closely coupled to the measuring and controlling elements. In order to maintain centralized control, however, an indication or record of the variable was desired on the board. This led to the development of "blind" pneumatic controllers which were entirely separate from the indicating or recording instrument and connected in the system only by pneumatic tubing. Divorcing of the control function made possible a reduction in the size of the indicator or recorder to some 5 in. square.

With a locally mounted controller and board-mounted indicator or recorder, there were still the needs for adjustment of the set point and provision for non-automatic operation from the control board. The blind controllers operated on a pneumatic-balance principle which easily permitted these functions. In this system, the measured variable is translated into a pneumatic pressure by a transmitter; the set point is also determined by a pneumatic pressure. The effects of these two air pressures are pneumatically balanced against air pressure to the control valve. Thus, the transmitter and air-pressure regulator for the set point can easily be separate from the controller.

For proper control, the new designs of blind controllers provide propor-

tional and proportional-plus-reset responses. One simplified design has a fixed proportional band and variable reset rate, and another design has a single adjustment for changing both the reset rate and proportional band. Still another design provides a combination of control actions: first, proportional-plus-rate action; second, proportional-plus-reset action.

Not all the recent advances in controller designs have been confined to pneumatic types. All of the basic modes of control have been made available in new and improved designs of electric-operated controllers employing the latest developments in electronic circuits. For example, vane-type controllers have been produced which provide extremely close switching action. Vane-oscillator circuits are now utilized on millivoltmeters, potentiometers, thermometers, pressure gages—even on an integrating mechanism. One manufacturer has developed a complete line of components for electric control with a miniature recorder for graphic panels. Indications today are that electric control may gain back much of the ground lost to pneumatic control in the process industries.

FINAL CONTROL ELEMENTS

For pneumatic control systems in the process industries, the workhorse of final control elements has long been the diaphragm motor valve. Friction on the valve stem and thrust of the controlled fluid on the inner valve are largely overcome in many applications by the use of a valve positioner. For heavier loads, however, the springless diaphragm motor

was put on the market several years ago. In this unit, the spring which opposes controlled air pressure from the control instrument is replaced by a constant air pressure; in conjunction with a valve positioner, this design makes available a useful positioning force ten times that obtainable from a comparable size spring-opposed diaphragm motor with a valve positioner.

For longer stroke of valve stem or linkage to another type of final control element, such as a butterfly valve, piston motors have been developed. Their operation and power are similar to the springless diaphragm motor.

For higher loads, up to 10,000 lb., one manufacturer has developed a unique design of pneumatic-operated power unit employing a rotary air motor. In this design, a reversible air motor operates a worm gear unit to drive the valve stem up or down. A valve positioner in the unit supplies 100-psi. compressed air to drive the motor in the proper direction called for by the pneumatic controller. Hydraulic actuators are also marketed for such heavy-duty service.

In the allied field of controlled-volume pumps, a new design was recently put on the market for the metered transfer of liquids in the very low flow range of 1 to 3,000 ml. per hr., against pressures as high as 1,000 psi. Its field of application is visualized primarily as the industrial laboratory or pilot plant, where such small flows are employed, but it has commercial applications, such as on automatic pH control. Delivered flow rates can be varied in response to the dictates of an automatic controller, either electrically or pneumatically operated.

PRODUCT QUALITY CONTROL

With the emergence from the laboratory of practical means for measuring product quality variables—such as viscosity, refractive index, density, and chemical composition—has come the increased use of such measurements for automatic control of product quality. Process engineers have long realized that control of such variables as temperature, pressure, and flow leaves much to be desired in controlling product quality. Periodic checks of quality in the laboratory introduce lags in the order of minutes or hours, whereas the ideal would be a continuous measurement of the product quality and immediate corrective action in the process to maintain this quality within the desired limits.

Other sections of this report describe a number of the newer instruments and detecting elements for the

measurement of variables related directly to product quality. Indicators and recorders for such variables can easily incorporate means for control action. The problem, still largely unsolved, is a practical means for automatically adjusting the set points of conventional controllers to maintain the desired product quality.

The answer to this coordination of control functions appeared over the horizon several years ago. It involves the use of computers, similar to those developed for the solution of complex mathematical problems, but not necessarily as complicated. Here again, as with servomechanism techniques, it seems that methods developed in other scientific fields can be adapted to the process control field, provided the right combination of manpower and knowledge is applied.

An example of how product quality control can be brought into the con-

trol loop with conventional controllers was cited several years ago. A variable related closely to product quality is measured and fed into a computer, together with impulses from temperature and pressure measurements and a materials ratio measurement. The computer digests all this information and sends out commands to adjust the controllers so as to maintain product quality. In such automatic systems the operator is completely out of the picture. Automatic warning or shutdown controls must be provided to protect against the failure of any component of the system to operate properly.

Along these same lines, devices are now being developed to enable automatic checking of when process equipment is wearing away or becoming fouled to a point where a unit could be shut down or by-passed for repairs and replacements.

Recent Progress in Measurements

Underlying all industrial instrumentation are the process variables. The list of important variables—temperature, pressure, flow, level, etc.—has not changed over the years. However, much greater emphasis is being placed on the measurement of some of the less common variables, such as the intensity and concentration of nuclear radiation.

With the development of guided missiles and jet engines, the measurement of force and acceleration has taken on added significance. The continuous measurement and control of many substance property variables, such as pH, conductivity, moisture content, color, and gloss, have graduated from novelties to everyday practicalities. As automatic product analysis techniques grow in development and acceptance, such variables as viscosity, infrared and ultraviolet absorption, oxidation-reduction potential and refractive index are becoming more significant.

TEMPERATURE

In the all-important field of temperature measurement, several new developments have come to light. In addition, there have been many improvements and refinements in the older, more conventional methods of measurement. The net effect has been to extend the range of temperature measurement and to increase the accuracy and sensitivity of the measuring means.

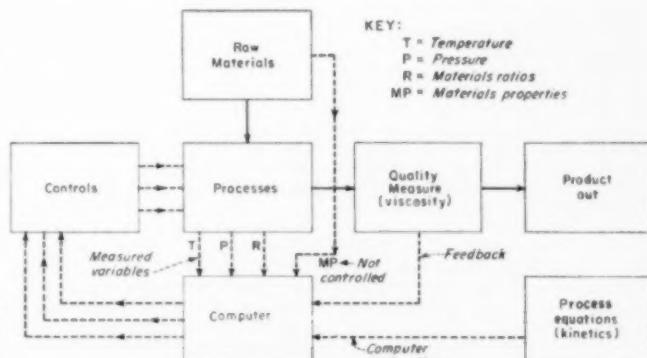
Thermistors (Bell Telephone Laboratories) are temperature sensing elements having abnormal tempera-

so that their interchangeability approaches that of thermocouples, they will find a wide use as primary elements for temperature measurement. Their resistance is sufficient to allow greater accuracy of measurement than is now possible with thermocouples or pure metal resistance thermometers. In addition to their use as primary elements, they have been incorporated in instrument bridge circuits to detect unbalances.

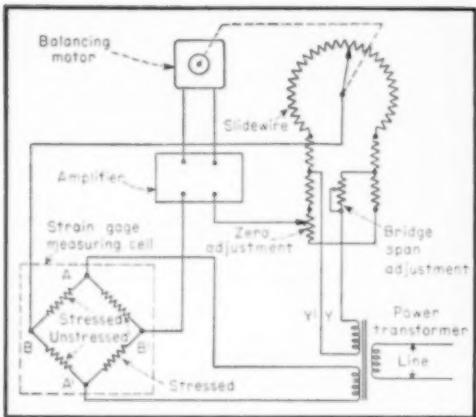
Noise Thermometer — This is a comparatively new development which can yield accurate temperature measurement within a fraction of a degree between -273 and +5,000 deg. F. Operation is based on amplification of the noise produced by molecular thermal agitation in the sensing resistor. It is a null-balance device for determining the ratio of two absolute temperatures, with an accuracy of 0.1 percent, by balancing the mean-square fluctuations of voltages across two resistors arising from thermal agitation at the temperatures to be compared. When the noise voltages from the resistors are equal, the ratio of the absolute resistances determines the ratio of the absolute temperatures.

In order to obtain the accuracy claimed, an observation time of 2 min. is required. If an accuracy of 1 percent is adequate, the observation time can be reduced considerably. Present difficulties exist in shielding, shock-mounting, and large input capacitance. Thus, use is limited to laboratory applications where high accuracy is required. With the advent of improved shock-mounting and shielding, this instrument may answer some limited needs where high accuracies are required.

Photronic Cell Bath Pyrometer — A type of photocell sensitive to infrared radiation, contained within a suit-



COMPUTER-CONTROLLER hook-up, shown here in hypothetical diagram, feeds back quality measure to govern conventional control variables.



STRAIN GAGES measure weight, pressure or torque by changes in resistance of stressed elements.

able tube, is available for measuring the temperature of molten materials, especially molten metals. The photocell is sensitive to the long wavelength energy emitted through the tube to the photocell. An output voltage proportional to the temperature is obtained.

Radiation Pyrometers for Low Temperatures—The range of radiation pyrometers has been extended for practical industrial purposes to temperatures as low as 125 deg. F. by incorporating a suitable means for controlling the temperature of the reference junction. An automatic unit maintains a constant temperature at the thermopile and thereby eliminates the effects of ambient temperature changes at this point. These units are coming into wide use wherever temperatures of moving objects, such as rubber and plastic calender rolls, must be measured.

Thermocouples and Resistance Thermometers—The conventional thermocouple and resistance thermometer have been improved during the past decade. Butt-welding the hot junction of thermocouples, long proposed but adopted commercially only in the last few years, and improved precision in manufacture have improved the speed of response of couples. Scores of special thermocouples for specific applications, including pencil and button couples, are now available, thus eliminating the former need of adapting a few standard designs to specialized needs. Similarly, design changes in resistance thermometer bulbs have improved the rate of heat transfer to the bulb winding, thus increasing sensitivity and speed of response.

Important advances have been made in the field of thermocouple extension

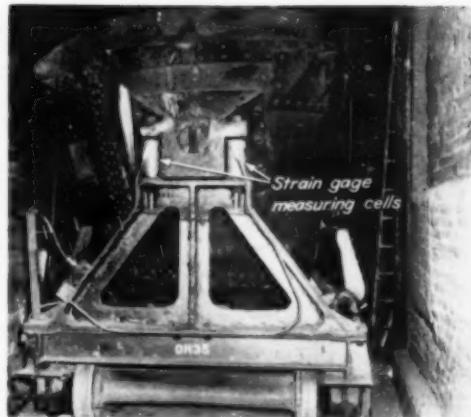
wire insulation. The advent of plastic and woven glass insulation has extended the serviceability of extension wire to both higher and lower temperatures. Metal and ceramic protecting tubes also have undergone many improvements.

PRESSURE

Strain gages and differential transformers are the newest elements for measuring pressure. These transducers possess several distinct advantages. Inasmuch as their operation is electrical, the distance between the point of measurement and that of indication or recording can be great. Since no external moving parts or mechanical linkages are involved, the measuring units can be hermetically sealed, making them resistant to moisture. Also, because of their inherent ruggedness, they can be subjected to very large overloads without damage.

Strain Gages—Essentially there are two types of strain gage elements. One, the bonded type, is affixed (usually by cement) to a member under stress. Strain on the wires constituting the gage is reflected by a change in resistance, which in turn constitutes a measure of the stress on the member. The second, or unbonded type, comprises a movable armature within a frame, with strain gage wires interlaced between the armature and frame. When the armature is subjected to strain, a change in resistance in the strain gage wires is produced. This change in resistance constitutes a measure of the applied force.

Bonded strain gages have proved successful in measuring pressures up to 200,000 psi., an important fact in that processes today are being conducted under increasingly higher pressures. Unbonded strain gages have



proven effective for measuring pressures up to 15,000 psi. With the latter type, a diaphragm exposed to the pressure being measured actuates the armature, thereby stretching the resistance wires and altering the balance of a bridge system calibrated in terms of pressure.

Bonded strain gages are finding increasing use in processing applications where continuous measurement of load or weight is required. Illustrative is the placing of a strain gage load cell in one of the supporting structures of a bin or tank to measure continuously the weight of its contents. The strain gage evaluates the stress on a beam of known modulus within the load cell. In similar fashion, unbonded type strain gages have found use where force or infinitesimal motion must be measured.

Differential Transformers—Motion transducers operating on the differential transformer and magnetic principles measure motions as small as 0.0001 in. These transducers can be used in connection with bourdon tubes for the measurement of pressures by connecting the transducer so that it measures the small movement of the tube.

In the a.c. voltage transducer, a movable core links three coils, a primary and two secondaries connected in series opposition. Movement of a plunger causes variations in flux linkages.

VACUUM

Utility, range and practicability of all basic types of high vacuum gages have been improved during the past decade. Many processes, including those in the food and electronics industries, have been much more efficient because of improvements in the

hot-wire and ionization vacuum gaging methods. The most recent development has been in the ionization gage.

The Alphatron ionization gage (National Research) employs a small quantity of radium sealed in an all-metal vacuum chamber as a constant source of alpha particles to act as an ionizing agent. The gas whose pressure is being measured is ionized as a result of collision with alpha particles. Positive ions collect on a grid, producing grid current proportional to the number of molecules of gas present in the chamber—that is, the pressure. Measurement of this current (from 10^{-11} to 10^{-15} amp.) is a measure of the pressure.

Effective range of this gage is from approximately 1 micron to 10 mm., without the burn-out problems usually encountered in the upper range. It is readily adaptable for use with electronic recorders and controllers.

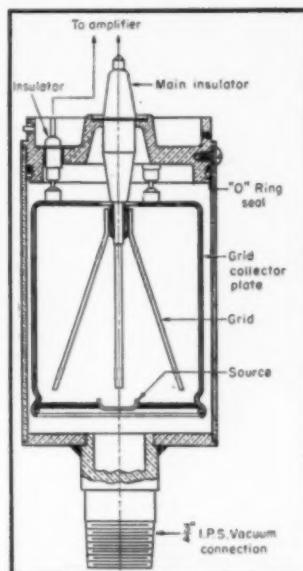
FLOW

Several improvements have been made in flow measurement, all by way of simplification, especially as regards installation and maintenance.

Mercuryless Meters—Although the aneroid differential meter body is not new, it has undergone many recent improvements. Advantages of the new meters include fast speed of response, elimination of mercury, require no seal pots, reduce or eliminate need for purging, and light weight and comparative ease of installation and maintenance. Several instrument companies now produce mercuryless meters.

Operation is based generally upon the accurate and sensitive pneumatic-balance principle, wherein the force of the differential pressure across the orifice or other metering restriction is opposed by the force of air pressure acting directly on a diaphragm or in a weighbeam system similar to that found in analytical balances. Air pressure balancing the force thereby becomes a measure of the differential pressure or flow, and is transmitted by a single air line to a pneumatic receiving instrument.

Electronic Propeller Meter—This unique meter (Potter Aeronautical Co.) utilizes a rotating propeller in the stream whose flow is being measured. The system comprises a flow-sensing unit having a rotor and magnet rotating within a non-magnetic housing, and an external pick-up coil connected to an electronic indicator or totalizer, or both. As the propeller rotates, the magnet produces a moving magnetic flux which cuts a coil located exterior to the pipe. This induces a



ALPHATRON ionization gage uses radium to measure very low pressures.

voltage whose frequency is a measure of the rate of flow.

Standard sensing elements are from $\frac{1}{2}$ to $\frac{3}{4}$ -in. I.P.S., with larger or smaller units available for particular requirements. Flows ranging from 0.2 to upwards of 3,200 gpm. can be measured. Outstanding characteristics of this meter include the inherent low pressure drop, operating temperature range from 4 deg. absolute to 1,000 deg. F., and its high pressure limit—approximately 20,000 psi.

Electromagnetic Meter—Operating principle of the Magnaflow (Mittelmann Electronics Div.) is based on the fact that a voltage will be induced in a conductor when moving through a magnetic field. This induced voltage is proportional to the velocity of movement and the intensity of the magnetic field. The apparatus comprises an electromagnet and a flow tube, with two platinum electrodes mounted flush with the inside wall of the tube. At present, use is restricted to fluids whose conductivity is at least as good as that of distilled water. It has been used successfully for the accurate measurement of low flows, including blood circulation in medical studies.

When this design is made available in larger pipe sizes, it probably will see increasing usage in the process industries. Apparently it is not affected by changes in viscosity, density or temperature. It has the additional

advantages of no moving parts and that it offers no restriction to the flow of fluid or contact of parts with the fluid. With an amplifier connected to the primary device, the unit can be made to indicate and record rate of flow continuously.

Ultrasonic Flowmeter—This is a new device in which sound waves are sent in opposite directions from a fixed point. The Doppler effect causes faster propagation in the downstream direction. The difference in time measured in the two directions is proportional to flow.

Rotameters—Use of the rotameter has increased very extensively during the past ten years. It has undergone many design improvements, including much improved methods for guiding the floats. In addition, many advancements have been made in extending the range and capabilities of this device and in the design of predictable elements.

Various types of meter tubes and floats are available to meet practically any requirements. The meters have been adapted, for example, for electric and pneumatic transmission, electric and inductance alarm units, and locally mounted indicating, recording, controlling and totalizing elements.

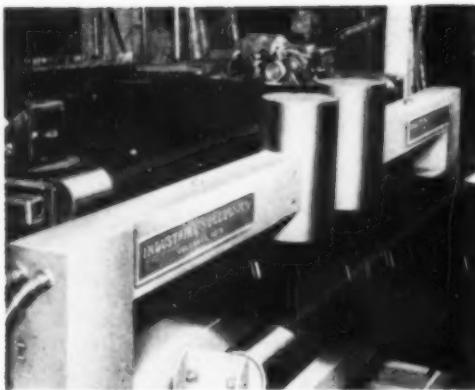
LIQUID LEVEL

Liquid level measurement has, over the period of the past few years, risen to a role of primary importance. Liquid level can be considered one of the key variables—on a par with temperature, flow and pressure—for most processes, both batch and continuous. Good indices of this status are the large number of new methods, systems and equipment brought out during the past ten years and the many instrument manufacturers (over 100) now engaged in producing liquid level measuring and controlling equipment.

Radiation Method—The radiation type liquid level device (Instruments, Inc.) was designed primarily for catalyst level control in cracking units. It is equally applicable for the measurement of liquid levels and fluid densities through container walls, thus eliminating seals and stuffing boxes.

This instrument operates on the principle that gamma radiations from a radioactive source vary in proportion to the density of any material between the radiation source and a detecting means (a Geiger counter). When used in a vessel where the density of the catalyst remains constant, variations in gamma rays become a function of the thickness or level of the catalyst bed.

Electronic Remote-Reading System—New equipment commercially



BETA RADIATION measures thickness of moving sheet.

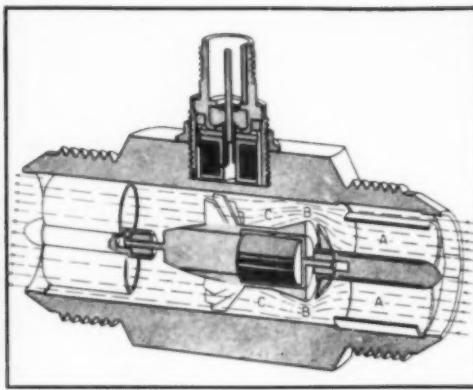
available (Shand and Jurs) is capable of gaging tank level for storage tanks, both low and high pressure, within 1 in., from 0 to 50 ft. of liquid level. This new development is of particular advantage in oil and gas storage terminals.

The system comprises indicating receiver with optional key-switch assemblies, transmitters, and four-conductor cable between each transmitter and the receiver.

The indicating receiver is a specially modified electronic wheatstone bridge instrument. Variable resistance, forming one leg of the bridge, is the float-positioned transmitting potentiometer assembly (transmitter). The instrument servo system balances the bridge by driving the balancing slide-wire to the null position. This position is indicative of the level in the tank. A single indicating receiver accommodates up to 12 tanks (transmitters), and additional key-switch cabinets, capable of handling 12 or 24 tanks, can be used in conjunction with the indicating receiver.

Each transmitter assembly consists of an explosion-proof housing inside of which are transmitting potentiometers and the driving arrangement. The drive consists of a sprocket wheel driven by a perforated stainless steel graduated tape which moves in accordance with a float that rides the liquid level in the tank. One potentiometer makes one complete revolution for each foot of liquid level change, while the second potentiometer is geared to make one complete revolution in 50 ft. of float travel.

Buoyancy devices are based on use of the torque tube, which has the outstanding advantage of being capable of picking up and translating into pressure of an operating medium extremely minute changes of liquid level with



ROTATING PROPELLER measures flow by induced voltage.

no determinable friction loss. Other distinct torque tube advantages are extreme sensitivity for process control work, no stuffing boxes required, and interface level measurement between two immiscible fluids for differences in specific gravities as low as 0.1. A number of companies produce this type of unit, in both external cage and internal types. Ranges vary from approximately 14 in. to 50 ft.

Basic principle of operation is weight measurement of displacement. A displacer heavy enough to sink in the measured fluid is freely suspended from a pivot arm. As the level of the liquid changes, the displacer is buoyed up by a force equal to the weight of liquid displaced. The pivot arm attached to the displacer is rigidly affixed to a thin-walled torque tube, which is essentially a torsion spring di-twisted by the weight of the unsupported displacer (at zero level) until it creates an equal opposing force. Changes in liquid level are thus directly reflected as twisting and untwisting of the hollow torque tube and simple rotation of a shaft inside the tube. The shaft, thus actuated, causes movement of a flapper in an air pilot mechanism which can provide both pneumatic control and remote level transmission.

Ultrasonic Level Device—This recent development (Bogue Electric Mfg. Co.) measures liquid level by transmitting pulses of ultrasonic energy from the bottom of a tank to the surface, where reflection occurs. By measuring the amount of time required for the pulse to traverse the liquid, an indication of level is obtained. Such units are particularly suitable when the number of measurements is large.

Other Level Systems—Several types of electrode devices are now commer-

cially available. These depend on the electrical conductivity of the measured liquid and utilize sensitive electric or electronic relays to operate control or alarm contacts. One system employing a simple electric relay and suitable probes can be used with most aqueous solutions of electrolytes or with other fluids having resistivities less than 20,000 ohm-cm. which will not be ignited by arcing.

For liquids of low conductivity, electronic relay-electrode systems provide increased sensitivity. Several devices are available for operation at resistivities up to 20,000,000 ohm-cm. With one such device, when the liquid makes (or breaks) contact with electrodes the volume of flow of electrons in the high-current amplifying tubes is changed.

Many other new mechanisms, designs and techniques for the solution of liquid level measurements and control have been evolved during the past decade. Included among them is the nitrogen gas purge system for catalyst level control in cracking units. This system depends on a constant gas purge through the pressure taps to measure head or static pressure.

Another new instrument operates on the basis of detecting the capacitance change caused by physical movement of the medium. Even television is now commercially employed as a method of remote gage glass level indication.

VISCOSITY

In many processes the ability to measure viscosity accurately plays an important part in the quality of the end product. Although sufficient accuracy has, in the past, been obtainable through the use of laboratory methods involving the taking of periodic samples, these methods had sev-

cial decided drawbacks. In the first place, they were periodic; there was no way of knowing whether viscosity changes were taking place between sampling periods. Secondly, skilled technicians were forced to spend valuable man-hours taking samples and transferring them to the laboratory. Finally, they made it necessary to duplicate processing conditions in the laboratory.

Because of these disadvantages, it was necessary to develop methods of accurately and continuously measuring viscosity right at the process and means for automatically controlling viscosity on many applications.

Torque Type—One method (Brookfield) employs a sensing element that is inserted directly in the process vessel. A calibrated spring measures the torque on a spindle that is rotated at constant speed submerged in the fluid. This spindle may be a calibrated cylinder, a disk, a paddle, or a number of cups, depending on the nature of the material and the viscosity range involved. The torque, which varies with the viscosity, is continuously measured and transmitted electrically to an electronic indicator, recorder or controller.

Ultrasonic Type—Another system (Rich-Roth) makes use of a probe that is inserted directly in vessels or pipelines. It uses ultrasonic waves in the probe and an automatic electronic computer. The computer converts the probe output instantly into viscosity measurements which can be transmitted to an indicating or recording instrument. There are no external moving parts and, since the probe is hermetically sealed, it is explosion-proof. It can operate at temperatures from -180 deg. to +650 deg. F. and at pressures up to thousands of atmospheres.

Rotameter Type—Still a third method (Fischer & Porter) uses two floats that are free to move vertically in a conically tapered rotameter tube. The fluid flows upward past these floats. The upper float is completely unaffected by viscosity; the lower float, on the other hand, is very sensitive to viscosity. For any given flow rate, the vertical displacement between the two floats is a measure of fluid viscosity. These float positions can be transmitted electrically to a recording or controlling instrument.

HUMIDITY AND DEWPPOINT

Wet and dry bulb thermometers and hair hygrometers continue in wide usage for determining humidity. However, the electric hygrometer and the dewpoint meter have made much progress in their design and utility.

Electric Hygrometer—Sensing element for the electric hygrometer is a plastic form upon which two metallic grids are stamped or wound, and the over-all form finally coated with moisture-sensitive lithium chloride. Because the electrical resistance of this unit changes when it is exposed to variations in humidity, humidity can be evaluated by the measuring circuit of the instrument.

The new units, widely employed in the textile and other process industries, are characterized by rapid response and high accuracy. They are especially convenient where it is desired to connect numerous humidity sensing elements to one central recorder.

Dewpoint Meters—Several systems have been developed for the automatic continuous measurement of dewpoint. In two systems, the basic principle employed is that of a mirrored surface exposed to the gas under measurement. Temperature of the surface is gradually reduced to the point where fogging of the mirror occurs, due to moisture condensation at the dewpoint. A thermocouple attached to the mirror is connected to a potentiometer to provide a continuous record of this temperature.

Another recently developed dew-point measuring element (Foxboro) utilizes the behavior of a hygroscopic salt in the presence of water vapor as its operating principle. The element consists of a thermometer bulb (electrical resistance or liquid expansion type) inside a thin-walled tube which is covered with a lithium chloride-impregnated glass tape. Two silver wires are wound on the outside of the tape and connected to a 25-v. a.c. source. As the salt absorbs moisture from the atmosphere, it becomes an electrical conductor, so that the resulting current flow between the wires raises the temperature of the unit until equilibrium is established.

CHEMICAL COMPOSITION

Measurement of chemical composition, including the direct quantitative analysis of process streams, is assuming increasing proportions in all phases of process operations. The applicability of pH, conductivity and oxidation-reduction measurement has been much expanded. Contributing greatly are improvements in electronic circuits used to evaluate cell outputs and the design of more practical cells. Improvements have also been made in the glass and reference electrodes. The variety of available cells has augmented the temperature and pressure ranges under which pH, conductivity and oxidation-reduction measurements can be effectively made.

Infrared and Ultraviolet Analyzers—Use of this equipment is rapidly gaining prominence in many phases of industry. Infrared and ultraviolet selective analyzers are adaptable to qualitative and quantitative determination of large numbers of plant streams and organic substances. Infrared analyzers are particularly applicable to hydrocarbons and other substances having complex molecular structures, while the ultraviolet type is primarily suited for elements wherein molecular excitation gives rise to characteristic electromagnetic radiations.

Selective Mass Spectrometer—Pressing needs precipitated by developments in the atomic energy program have led to the adaptation of the mass spectrometer to continuous processes (Consolidated Engineering). Employing a mass spectrometer to monitor directly a complex plant stream provides a very effective method of controlling composition, since it indicates a change in analysis in a matter of minutes. Moreover, it is effective in handling complex compositions not readily analyzed by other techniques.

Development of a mass spectrometer for the selective analysis of complex streams is contingent upon two innovations, namely, automatic standardization of the spectrometer and automatic scanning of a limited number of mass peaks in stepwise fashion. Standardization is accomplished against a gas of constant composition.

Gas Analysis—Oxygen analyzers operating on the paramagnetic properties of oxygen are capable of measuring oxygen for the entire range of concentration from a few parts per million to 100 percent. Measurement is based on the fact that oxygen is strongly paramagnetic (attracted into a magnetic field), whereas other common gases are slightly diamagnetic (repelled out of a magnetic field). This property is of such magnitude that it is possible to determine accurately the oxygen content of a sample gas by measuring the volume magnetic susceptibility of the gas. This can be measured from the change in magnetic force acting on a test body suspended in a non-uniform magnetic field when the test body is surrounded by the gas.

Continuous and automatic analysis of hydrogen sulphide is now possible with analyzers (Rubicon Co.) utilizing a photometric measuring circuit. These analyzers are unique in that a self-balancing bridge circuit is employed with dual (reference and measuring) photocells.

In the H.S. analyzer, a flow of the gas under test is fed continuously into

the analyzer, where it passes through the restricted area of a permeable white tape. The white tape is impregnated with lead acetate and other chemicals which will assure the complete conversion to brown lead sulphide of all hydrogen sulphide present in the gas, regardless of its concentration. Light of the proper spectral quality is focused so as to illuminate the exposed area of the tape. The reflectivity of this area as compared to a similar area of the tape not exposed to the gas is measured by two photocells in a bridge circuit.

One new type of combustible gas analyzer (Davis Emergency Equipment Co.) measures the temperature increase of a heated platinum filament by a thermocouple rather than by the resistance of the filament itself. This gets away from the zero drift of the older resistance type. When a combustible gas or vapor is admitted to the analyzing chamber, the gas burns, and the temperature of the filament increases in proportion to the concentration of the gas.

Refractive Index and Dielectric Constant—Refractometers have been advanced from the realm of manually adjusted instruments, operated in conjunction with the human eye, to that of automatic devices operating on a photoelectric-servo basis suitable for process control. Development of this instrument has established the refractive index of a process liquid as a variable for controlling product composition. A typical control application is found in the purification of styrene by fractional distillation. Here, the boiling points are very close together thereby making control by temperature difficult and unreliable. Since the refractive indexes of the two materials are widely separated, control from this variable is much more effective.

Allied to the measurement of refractive index is the continuous measurement of dielectric constant. Instrumentation for the measurement and control of dielectric constant is not yet very well developed. However, since it provides potentially a means of controlling the composition of gases and solids, further refinement is but a matter of time.

DENSITY

Continuous density measurement of flowing liquid is now feasible with a recently developed apparatus (Precision Thermometer & Instrument Co.). The unit operates on the change in buoyancy of a totally submerged plummet which supports one end of a looped chain. The plummet is so weighted that at the middle of the

density range, it will support half the weight of the calibrating chain, the reference point supporting the other half. Changes in fluid density put more or less weight of the chain on the plummet.

Position of the plummet, which acts as an armature, is determined by an inductance coil. This method of measurement and control of density is now being used for many basic processing operations.

GLOSS, TURBIDITY, COLOR

Appearance factors, in general, are

subject to photoclectric measurements and, with improvements in photoclectric techniques, numerous types of apparatus have been recently developed for their measurement. All operate basically by evaluating the amount of light transmitted or reflected through or by the substance in question under various geometrical conditions. Devices have been recently perfected to measure the turbidity of flowing liquids, clarity of beer, smoke from stacks, surface gloss of paper, reflectivity of surfaces, and color of raw cotton.

Recent Progress in Instruments

For a number of years, deflectional principles of operation have been employed in instruments. The simple millivoltmeter and pressure spiral are examples wherein calibrated physical displacement is a measure of the variable. In numerous cases such methods of operation are still entirely adequate and offer the simplest and most dependable instrument system.

In certain applications, however, the need for increased speed of response and total absence of hysteresis in measurement or control has led to the development of force-balance instruments, wherein a force resulting from a change in the variable is opposed by a force which is a measure of the variable. For example, the new mercuryless flow transmitters and non-indicating pneumatic controllers operate on a pneumatic force-balance principle. Because the component parts of a force-balance instrument move only a small distance (thousandths of an inch) in the measurement or controlling action, a large increase in speed of response is achieved. Furthermore, there is practically no hysteresis which can act as a dead spot in control applications. In electrical measurements, equivalent methods of electrical force balance, or current-balance, have similar advantages in application and have been employed in new systems.

ADVENT OF ELECTRONIC INSTRUMENTS

Ten years ago, the use of electronic components in indicating, recording and controlling instruments was just being recognized as an important development in the field of instrumentation. An industrial model of Brown's electronic potentiometer had already begun to find increasing applications in the process field for temperature measurements using thermocouples.

Representative of the many new electronic industrial instruments are the following designs:

The new Dynamaster line of electronic instruments (Bristol) employs the continuous null-balance principle for use with a d.c. potentiometer circuit, a.c. wheatstone bridge, etc. The major components of the balancing system are the d.c. to a.c. inverter, input transformer, electronic amplifier, slidewire and balancing motor.

The unique design of the double-pole double-throw inverter produces exceptional switching symmetry. The combination of this symmetry characteristic and the amplifier frequency response provides a d.c. null detector which is unaffected by stray a.c. voltages of considerable magnitude. During an unbalanced condition, voltage is applied to input of the electronic amplifier, where it is greatly amplified. This amplified unbalanced condition is then impressed on the control winding of the balancing motor, causing it to rotate in the correct direction to move the slidewire contact and restore balance.

During the last few years the Dynalog line of electronic instruments (Foxboro) has appeared for measuring emf., resistance, capacitance, and inductance, or process variables converted into these electrical functions. This line features such innovations as replacement of the slidewire by an air-capacitor and use of a solenoid balancing drive. Direct comparison to reference standards eliminates intermittent standardization procedures.

As change in the measured variable is detected by the primary sensing element, the measuring circuit becomes unbalanced, setting up an alternating voltage which is amplified by a conventional a.c. electronic amplifier. The presence and direction of the amplified unbalance voltage are then detected by an electronic circuit, and the current balance between two solenoid coils changed, causing their cores to move the balancing capacitor, thus re-establishing electrical balance. Indi-

cating, recording and controlling mechanisms linked to the balancing capacitor are simultaneously moved to the correct reading.

The new electronic Speedomax instruments (Leeds & Northrup) employ an electrical continuous null-balancing system based on any of the common measuring circuits, such as the potentiometer, a.c. wheatstone bridge, d.c. wheatstone bridge, and the like. The basic balancing system of the instrument (calibrated as a potentiometer) consists of a converter, input transformer, electronic amplifier, measuring slidewire and balancing motor. Regardless of the type of measuring circuit employed, the electronic amplifier acts as the unbalance bridge detector, which induces a voltage of such phase relationship that the balancing motor operates to move the slidewire contact in the proper direction to maintain balance.

SPECIALIZED INSTRUMENTS

A number of instruments particularly designed for special measuring and recording problems have recently been released. In general, these instruments, described as follows, have extended effective instrumentation to fields hitherto confined to cumbersome, manual or complex techniques.

Scanning Instruments—Exemplar of the trend toward scanning and monitoring systems is one which will continuously and automatically monitor up to 270 separate temperature points. The system basically comprises a recorder, rectifier and control unit. Incorporated in the system is an alarm which gives audible and visual indication when the temperature at any one point exceeds a limit. The system provides flexible, completely automatic temperature scanning. The operator decides whether he wants temperature recorded only when set point is exceeded, temperatures recorded continuously, no temperatures recorded, or only manually selected points recorded.

X-Y Recorders—Automatic plotting of a curve which shows the continuous relationship of two variables, one as a function of the other, is accomplished with these new instruments. The instruments incorporate a strip-chart single-pen recorder; the chart drive mechanism is actuated by an independent measuring system. Thus, the instrument incorporates two measuring systems, one of which actuates the recorder pen while the other motivates the chart. With this arrangement, the chart is driven up and down in response to changes in one variable simultaneously with the movement of the pen in response to changes in a

second variable. The result is a curve which continuously evaluates one variable in terms of the other. Both pen and chart are positioned by associated independent measuring circuits and may be actuated by any d.c. source.

Duplex Recorders—The simultaneous recording of two independent variables on a common chart facilitates many analyses involving comparison measurements. New recorders have been designed to provide simultaneous measurements of practically any combination of two independent variables and to record them on a single chart. The duplex recorder incorporates two separate measuring systems with associated pens which are entirely independent, and traverse the full chart width without interfering with each other. The two measuring circuits are also entirely separate, and the actuation and range for each can be the same or totally different. Thus, for example, one measuring circuit may record temperature and the other speed; one emf., and the other current, and so on.

Narrow-Span Instruments—The increasing importance of the measurement of low-level potentials in many scientific and technical investigations has brought about the development of a potentiometer circuit which permits the measurement of spans as narrow as 100 microvolts. Instruments embodying this new circuit have recently been made available. In general, narrow-span instruments find ready use wherever the accurate measurement of d.c. potentials of the order of microvolts is required. Potentials as low as 0.1 microvolt can be precisely determined.

Vibrating Capacitor Electrometer—This instrument (Minneapolis-Honeywell) is designed to measure and record extremely small currents, such as those produced in ionization chambers. Measurements are recorded by a strip-chart potentiometer from signals detected and amplified by a sensitive preamplifier unit which incorporates the vibrating capacitor. Currents as low as 10^{-16} amp. (a billionth of a microampere) can be consistently recorded on a linear chart. The instrument combination can also function as an extremely high-impedance millivoltmeter for measurements down to 10^{-4} v.

Although the electrometer is designed particularly for the measurement of currents from ionization chambers, it can readily be used for other measurements and applications. For example, the electrometer can be used for recording the output of vacuum phototubes in measuring light intensities for ultraviolet or visible

spectroscopic analyses and other applications where light intensity is a factor.

For measurements as low as 10^{-16} amp., the instrument can be modified to use a rate-of-charge method of measuring. For this, the input resistor is replaced by a fixed capacitor which is directly charged by the input current. The value of the current is computed by multiplying the known capacity of the fixed capacitor (in farads) by the measured slope of the recorder trace (in v. per sec.). The chart record permits accurate timing and measurement.

DEVELOPMENTS IN RECORDING MEANS

One of the most important recording developments of the past decade has been the small strip-chart recorder for graphic panels. The well established miniaturization trend has carved an important niche for these 3-in. strip-chart recorders.

One unique printing apparatus (Foxboro) designed for multiple records on circular chart recorders utilizes a single pen arm with a permanent magnet, individual dot-printing pens, and a synchronized ink pad and pen-holding mechanism. The pen arm moves to the pen holder, selects an inked pen, returns to the proper position on the chart as dictated by the measured variable, prints a dot, returns the pen to the pen holder and selects the next color-coded pen. Six records can be accommodated with this system.

Of particular import to systems where printing of a large number of records is required is the Teledeltos printing apparatus. Electrically sensitive tape is used for very rapid recording of data in digital form. Electrodes with an electric potential with respect to the roller over which the tape is running produce a dark mark on the tape when they are energized. With one particular system (Potter) it is possible to record permanently up to 150 6-digit numbers per sec. Another company (Atomic Instrument Co.) uses electrically sensitive tape and a 3-by-5 dot array to graphically print single digit numbers. Other printing devices employ electrosensitive or heat-sensitive paper.

Among the various digital recording systems now available or in the final stages of development is one wherein signals from linear differential transformers are recorded digitally on tape (Automatic Temperature Control Co.). This method has been used for weighing, pressure measurement, temperature measurement, and any measurement which can be made in conjunction with the motion of the

linear differential transformer. Other late developments include the use of punched cards as a recording means.

ADVANCES IN TELEMETRIZING

Recent developments in methods of telemetering have extended the distance which it is possible to telemeter variables from a matter of yards to one of hundreds of miles. Essentially, long-distance telemetering involves (1) interpreting an electrical measurement of a variable in terms of modulation suitable for application to a micro-wave, carrier frequency, or similar channel transmitting medium, and (2) receiving the channel transmission and interpreting the modulation in terms of electrical quantities.

One type of telemetering equipment (Westinghouse) utilizes an electronic generator transmitter with an output frequency proportional to an applied millivolt quantity. The generated frequency from the transmitter is sent through the transmission channel (micro-wave equipment, power line carrier equipment, or two-wire connecting line) to the telemeter receiver. The conversion from frequency to millivolts is performed by the receiver. This is an electronic device whose d.c. millivolt output is proportional to the received frequency. Indication or recording is then accomplished by using a potentiometer recorder. The resultant indication is proportional to the d.c. millivolts received.

General Electric produces two different types of telemetering equipment—the frequency system, designed for operation over micro-wave and power line carrier-current channels, and the torque-balance system, designed for two-wire transmission only.

The frequency system operates so that the variable to be measured is resolved into electrical values by an appropriate primary detector, and the resultant signal is applied to the telemeter transmitter.

The torque-balance type employs a photoelectric control system comprising a light source, a movable mirror, two phototubes and d.c. power supply. The magnitude and polarity of the current output from the power supply are proportional to the division of light between the two phototubes.

SUMMARY OF LONG RANGE TRENDS

Electric vs. Pneumatic Systems—The relative advantages and limitations of electric and pneumatic control systems have been the subject of long discussions over the years. During the last few years, however, there has been increasing evidence of interest toward complete electric sys-

tems. Climatizing and transmission lengths are critical factors that will play an ever increasing role.

Wireless Transmission—Relative costs will necessarily dictate the extent to which wireless transmission is employed. Fields of application will probably remain somewhat limited. Long range telemetering, particularly for accounting and supervisory purposes, should expand sharply.

Miniatrization and Graphic Panels—A very definite trend toward miniaturization of not only indicators, recorders and control mechanisms, but also control relays, components and circuits is well established. Transistors and printed circuits, for example, may be just around the corner. In industries where precise control is required, instrument usage is large, and centralized control rooms practical, the use of graphic panels with miniature instruments will help to eliminate confusion and effect economies in space and operator training time.

Greater Thought to Equipment Design—Undoubtedly the evolution of instrumentation from an art to a highly specialized science will result in more carefully calculated equipment designs. The users, from the planning and operating personnel to the maintenance men, will receive greater consideration for his wants, suggestions and complaints. Corrosion-resistant materials, hermetically sealed units, plug-in unit construction, and more pleasing color schemes and finishes are but a few factors leading to more functional designs.

Improvements in Sensing Devices—The basic trend toward more specialized and more accurate sensing or detecting elements for temperature, pressure, flow, and other physical measurements appears well defined. In addition, there is considerable development under way on elements measuring physical quantities which are directly related to product quality, such as refractive index, dielectric constant and density.

Improvements in Final Control Elements—Continued refinements on existing final control element designs and new methods of proportioning gases, liquids, solids and mixtures are to be expected in increasing numbers. Control valves and auxiliary components are now experiencing a rebirth in design which may continue for many years to come.

Electronics—Extrapolation of the present trend to electronic instruments, components, circuits and related developments shows what may be anticipated in the future. The electronic trend continues on—at an increased tempo.

Servo Techniques—Tremendous expansion in servomechanism techniques may be expected as processes become increasingly complicated and the benefits of these techniques are better realized. System engineering based on servo techniques forms the foundation for the automatic factory of tomorrow.

Product Quality Control—There is an increasing interest in the measurement of those quantities directly related to product quality. End-point analyzers, for example, provide instantaneous indication of the final composition of a product so that immediate corrective action can be taken.

Computers eventually may play a significant role in automatic control by bringing product quality measurements into the control loop. Although conventional pressure, temperature and similar process variable control instruments would be utilized, a computer might be used to interpret the quality measure and in turn establish regulation over the various process variables.

WHAT THE FUTURE PROMISES

Theories for the optimum use of automatic control and instrument designs today have made tremendous strides in the last decade. Yet no one in the field of instrumentation will claim that we are near the ideal goal. Servomechanism techniques, although highly developed for linear systems, will require much work in non-linear systems, and teams of data must be compiled on process and instrument characteristics so that practical conclusions can be reached.

An increasing exchange of information between scientists in the fields of servomechanisms, communications, and even biochemistry, where similar control problems exist, cannot help but bring to light new approaches to the problem of automatic process control. One such approach may dwarf the present servomechanism techniques in importance and revolutionize the industry. Two things are certain—there will be a fascinating challenge to workers in this field for years to come, and there will be increasing opportunities for young engineers with a fundamental knowledge of the newer techniques.

The mist of confusion in present-day trends and innovations should not obscure the fact that automatic control is now serving industry more than ever before to increase process efficiency, decrease waste and spoilage, improve product quality, step up production rates, upgrade operating personnel, and provide many other benefits.

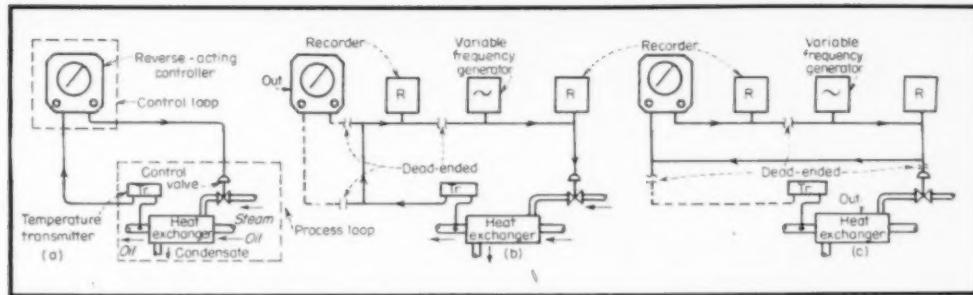


Fig. 1—(a) Simple closed loop consisting of controller and process; (b) here the loop is opened to determine frequency response of the process; (c) arrangement for finding frequency response of controller.

New Tools for the Instrument Engineer

Along with his older ways of showing process and instrument characteristics, the instrument engineer now has frequency response.

R. E. CLARRIDGE and W. J. BERK

Automatic control is no longer a luxury in the process industries. On the contrary, the successful incorporation and use of automatic controllers in a process is often vital to its success. In fact, as demand for quality at low cost has increased, there has been a definite trend toward continuous processes. Most of these will not perform satisfactorily without automatic control, since a human operator cannot apply the constant vigilance that is required and is possible only with automatic controllers.

Many devices are available for providing automatic control. Each appears

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to fill a given need in industry—otherwise it could not exist in a competitive market. After the process engineer has decided which variables must be controlled, and the accuracy required in each case, then the instrument engineer is faced with the problem of selecting the proper instrumentation. There are the obvious instrument requirements which must receive first consideration, among them ruggedness, dependability, corrosion resistance, and the like. Of equal importance, but far more difficult to determine, are the control effects which these instruments must have to obtain the desired results. Fortunately, the instrument engineer has a number of tools which can assist him in selecting these controller responses, but their use and value depend on process information.

PROCESS INFORMATION

At present there are two practical ways of passing along process information to the instrument engineer. The first is by means of a process signature curve and the second, the frequency response diagram. In this paper, then, let us look at the process as it would interest an instrument engineer, and follow with a review of fundamental control responses, process signature curves, and frequency response analysis.

Automatic controllers cannot be selected properly for any process without some knowledge of the process. The actual material being handled and

the possible chemical changes occurring are important to the instrument engineer only in their possible effect on the physical constants of the process. The most important physical constants are transportation lags and capacity lags. These lags, as they exist in the process, determine to a great extent the responses which are required in the instrument. Also, they determine the adjustment of the control effects, and limit the accuracy of the control which can thereby be obtained.

From the instrument engineer's standpoint, the complete process includes the control valve and the primary measuring element. Refer to Fig. 1a which illustrates a typical vapor-liquid heat exchanger of the shell-and-tube type, with an automatic temperature controller applied to it. The sensitive element is in the outgoing liquid while the valve varies the steam flow to the shell in accordance with the dictates of the controller. The process is considered to include the sensitive element and the valve, because the process determines their size and character. In other words, neither the valve, the sensitive element, nor the heat exchanger can be changed at the discretion of the instrument engineer. Therefore, he must select, adjust and produce satisfactory results with the best controller that can be had for the given equipment. It is only when the performance is unsatisfactory, or is likely to be, that

the process, the sensitive element, or the valve can be altered. Fortunately, as the knowledge of instrumentation has increased, compromises have been effected which have produced control that would not otherwise have been possible.

CONTROLLER RESPONSES

Referring to Fig. 1, note that the output from the process is the input to the controller and the output from the controller is the input to the process. These signals (pneumatic, electric, etc.) should not be confused with the actual materials being processed in the equipment. In fact, to the instrument engineer, the material going through the valve (steam in this case) is the controlling medium, and the material going past the sensitive element (liquid) is the controlled medium. Now it is customary to describe any dynamic (changing) device by the output y in terms of the input x . Specifically, the character of the controller can be determined by changing the input and observing the output. If we choose to make a small step change in the input of the controller, as illustrated in Fig. 2a, and the output changes a proportional amount as illustrated in Fig. 2b, the controller has a "proportional" response. Mathematically, this can be expressed as:

$$y - y_0 = B(x - x_0) \quad (1)$$

For reasons which will be apparent later, this equation is often expressed:

$$(dy/dt) = B(dx/dt) \quad (1a)$$

On the other hand, if the output of the controller changes as shown in Fig. 2c, there is an additional response called "automatic reset" which changes at a rate proportional to the input. The reset response alone is:

$$(dy/dt) = A(x - x_0) \quad (2)$$

and the response shown in Fig. 2c is a combination of the proportional and reset responses equated as:

$$(dy/dt) = A(x - x_0) + B(dx/dt) \quad (3)$$

If the response of the controller to the stepwise input is as shown in Fig. 2d, it has a proportional and a derivative response. A simplified equation for derivative response is:

$$y - y_0 = C(dx/dt) \quad (4)$$

This equation is an exact equation for a "perfect" first-derivative mechanism. The curve in Fig. 2d is typical of pneumatic and electric derivative devices which do not follow the equation exactly. In the first approximation they can be considered to follow the equation and further distinction is beyond the scope of this paper. This therefore approximate equation can also be expressed:

$$(dy/dt) = C(dx/dt)^2 \quad (4a)$$

For a controller with both proportional and derivative responses, the approximate equation is:

$$(dy/dt) = B(dx/dt) + C(dx/dt)^2 \quad (5)$$

The equation for a controller with all three responses is

$$(dy/dt) = A(x - x_0) + B(dx/dt) + C(dx/dt)^2 \quad (6)$$

$$(dy/dt) = SR(x - x_0) + S(dx/dt) + ST(dx/dt)^2 \quad (6a)$$

where $S = B$, $R = A/B$ and $T = C/B$.

This is about as far as we can go with the development from a visual inspection of the responses. However, it takes little imagination to examine Eq. (6) and realize that the responses are in reality three terms in a series—that additional terms could be added to both sides of the equation. Fortunately, from the engineer's standpoint, these three control responses seem to be quite adequate for most of the problems in process control. In fact, the so-called "easy" control problems may require only one or two responses. Note that the three constants, A , B , and C determine the magnitude of the various responses and in this sense they are controller adjustments.

As mentioned previously, not all controllers have these three responses (proportional, reset and derivative). These more limited controllers can be used only on "easy" applications. An application is considered easy if (1) its time lag is small, (2) if its reaction to a valve movement is small and gradual, if the load changes on the process are small, gradual, or infrequent, or finally (3) if top-flight performance is not required. For simplicity, ease of adjustment and economy, it is customary to select a controller with the minimum number of responses which will meet the needed requirements.

SIGNATURE CURVES

One of the practical ways of passing along process information to the instrument engineer is by means of a process signature curve. This is the curve (transient response) which is obtained by disconnecting the controller from the control valve, as in Fig. 1b, making a "step" change to the valve and recording the resulting change in the process variable. In pneumatic systems, it is customary to make a 1 psi. change in the loading pressure on the diaphragm motor. The output process variable will usually respond in an S-shaped curve. This curve is the signature curve of the process, and from it the performance of the process with various controllers can be approximated at that temperature and load.

S-shaped curves as in Fig. 3 are characteristic of most industrial processes and indicate that the processes

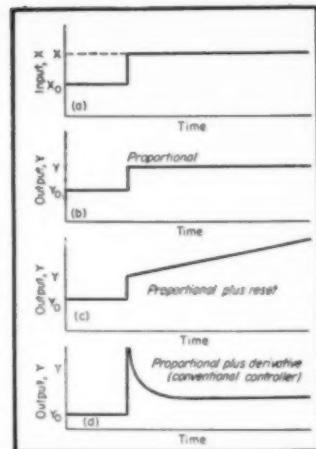


Fig. 2—Step change input and corresponding output responses of proportional, proportional plus reset, and proportional plus derivative controllers.

have two or more time constants* and some degree of "self-regulation." The curve of a two-capacity process with time constants $T_1 = 16.7$ sec. and $T_2 = 0.5$ sec. is illustrated in Curve A. The addition of a third capacity lag $T_3 = 2.5$ sec. will alter the curve to that shown in Curve B. If a transportation lag $T_{tr} = 8$ sec. is added instead of the third capacity lag, the signature curve will be that shown in Curve C.

Self regulation is that characteristic of a process which inherently tends to make the process variable stabilize at a new value after a load disturbance, independent of a controller. A two-capacity process without self-regulation is illustrated in Curve D of Fig. 3. A typical process with a high degree of self-regulation is the temperature control of an open kettle containing an evaporating material a few degrees below the boiling point. Conversely, if the kettle held a material undergoing an exothermic reaction, there would be zero self-regulation.

As we have previously seen, the ease or difficulty of controlling a process can be determined from its signature curve. The length of time a process takes to first respond to a step change, and the rate of process change once it does respond, are measures of the process controllability. This was recognized by Ziegler and Nichols in 1941¹ when they first proposed the formulas given below for determining the constants S , R , and T shown in Eq. (6a).

* The time constant is the value of $1 - 1/e = 0.632$. It represents 63.2 percent of the time for an exponential change to reach its final value.—Editor.

This equation is Eq. (6) rewritten for conventional pneumatic controllers in terms of the Ziegler-Nichols constants. While their work can be generally applied, their data were expressed in the adjustments of a pneumatic controller. Since pneumatic controllers are the most widely used in the process industries, the Ziegler-Nichols recommendations are reproduced in the tabulation below, in the same form as in the original paper. Thus, it can be seen that if the signature curve of a process is known, the corresponding instrument settings for optimum control are readily determined as shown in the magnified diagrams, right of Fig. 3.

Proportional

$$\text{Sensitivity } S = 1/R_L L$$

Proportional plus reset

$$\text{Sensitivity } S = 0.9/R_L L$$

$$\text{Reset rate } R = 0.3/L$$

Proportional plus reset plus derivative

$$\text{Sensitivity } S = 1.2/R_L L$$

$$\text{Reset rate } R = 0.5/L$$

$$\text{Derivative time } T = 0.5/L$$

FREQUENCY RESPONSE

Frequency response is the latest analytical tool available for solving process control problems. Experimentally, the method imposes a cyclic (sinusoidal) input disturbance on an

open loop. Then note is taken of the resulting output disturbance for various input frequencies. Thus each component part of a process, or a controller, can be separately analyzed and its characteristics graphically expressed by an individual frequency response diagram sometimes called a Bode diagram. These individual diagrams can be combined to give an overall picture of the process controllability, the effects of the controller responses, and the approximate "optimum settings" of each response.

Frequency response data are obtained experimentally in the following way: Fig. 1a consists of two open loops, the process loop and the controller loop, which are connected together in normal use to form a closed loop, as shown. To obtain frequency response diagrams of the process loop, the control loop, or their component parts, for use in analytical evaluation, the loop is opened in various ways. A variable-frequency generator which produces a small sinusoidal input variation (in this case, a variation in pressure) is imposed on the open loop and the sinusoidal output variations noted for steady state conditions. Fig. 1b

shows how the response of the process would be obtained, with the controller out of the loop. Fig. 1c shows the arrangement for the controller alone.

As the figures show, the input and output variations are recorded for comparison. The ratio of the amplitude of the output wave to that of the "forcing function" (input) is the "gain" of the loop. The phase relationship or lag of the output wave, in relationship to the input wave, is also noted. Phase lag is expressed in degrees, a lag of one full cycle being equal to 360 deg. Gain and phase values are graphically represented as functions of the sinusoidal input frequency.

A frequency response diagram, therefore, consists of two curves, the phase curve and the gain curve. The frequency (common abscissa) is usually expressed in radians per second (one cycle equalling 2π radians). The phase is plotted in angular degrees and the gain is often plotted in decibels (db.). The decibel measurement originated in the communication field and is convenient for several reasons. Conversion of gain to decibel units is relatively simple, the gain in db. equalling $20 \times \log_{10}$ gain.

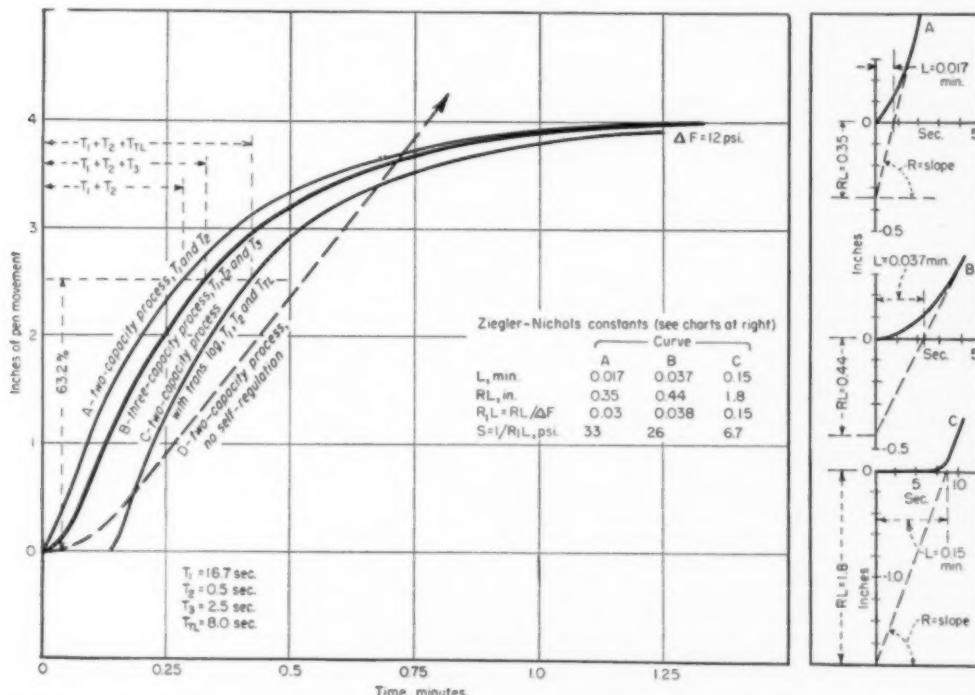


Fig. 3—Signature curves for a two-capacity process with and without transportation lag; a three-capacity process; and a two-capacity process without self-regulation. Shows at right curve analysis by the Ziegler-Nichols method.

CONTROLLER RESPONSES

If the control instrument (Fig. 1) is a proportional-response controller and has a gain of 1.0 the output sine wave amplitude will be equal to the forcing function amplitude. Correspondingly, if the controller has a gain of 10, the output amplitude will be 10 times the input amplitude. Fig. 4a (solid lines) shows the frequency response diagram for this proportional-response controller. The diagram also illustrates the effect of changing the controller gain from 1 to 10. A change in controller gain raises, or lowers, the gain curve, but does not appreciably alter the phase curve. The diagram also shows that at high frequencies the controller can no longer fully respond to the rapid cyclic variations and there is a decrease in the actual gain and a corresponding increase in the phase lag. This is known as the cut off point of the controller.

Addition of the derivative response to a proportional response controller is illustrated in the broken-line curves of Fig. 4a. The derivative response contributes a phase lead to the controller at high frequencies. This phase lead is very beneficial and tends to offset the phase lag characteristic of all processes at higher frequencies. Effect of changing the derivative time T_D is also illustrated.

Fig. 4b (solid lines) graphically illustrates the response of a proportional-plus-reset controller. Automatic reset produces a very high gain in the controller at low frequencies which is necessary if the process is to return to the control point after a load change. Note the initial lag of 90 deg. associated with the reset response. As the reset rate is increased, both the phase and the gain curves are shifted a proportional amount horizontally to higher frequencies.

The frequency response of a controller with all three responses is shown by the broken line curves of Fig. 4b. An important feature of this diagram illustrating the advantage of the decibel coordinate is the introduction of the straight line approximations. The straight lines intersect at two points: $1/T_D$, the derivative corner, and $1/T_R$, the reset corner. T_D and T_R are the time constants of the derivative, and the reset responses respectively. They are equal to the reciprocal of the frequency (expressed in radians per second). At this same corner frequency the phase angle has reached 45° of the 90° deg. for which each individual time constant is responsible. The phase angle for each time constant is the arc tan of the product of the frequency and the time constant. It is

evident that a calculated frequency response diagram of the control loop can be constructed if the time constants of the controller responses are known.

PROCESS DIAGRAMS

Reverting to Fig. 1, we see that the process open loop consists of the control valve, the heat exchanger, and the measuring system. Furthermore, for simplicity, each of these process components can be approximated as an individual time constant. Each time constant in the process is responsible for an ensuing reduction in gain of 20 db. per decade and a corresponding phase lag which reaches a maximum of 90°. A two-capacity process would have a frequency response diagram similar to that illustrated in the solid-line curves of Fig. 5a. Associated with the time constants of a process are other types of lags known as transportation lags, or dead-period lags. Thus, a temperature measuring bulb located Z ft. from the exchanger would have a transportation lag (in seconds) equal to Z divided by the velocity (ft. per sec.) of the controlled medium. Also the lag of transmission tubing can be conveniently expressed in terms of transportation lag for those frequencies with which we are concerned. There is no reduction in gain with transportation lag, but only a rapid increase in the phase lag as the broken-line curve of Fig. 5a shows.

This phase lag in radians is equal to the product of the frequency and the transportation time.

A frequency response diagram can be constructed irrespective of experimental work if the main time constants (corners) of the process are known. The straight line approximation method is used to construct this calculated diagram which in most cases is very similar to that determined experimentally. If the ratio of any two time constants is less than 10, the calculated diagram can be conveniently constructed by the use of a phase shift ruler². The ruler measures the amount of phase contributed at each frequency by each time constant of the process. The phase contributions are then added at each frequency to determine the phase angle. The ruler also has corrective db. values for correcting the straight line approximation curve of gain values.

In Fig. 5a for our two-capacity process the straight-line approximations indicate that the time constants T_1 and T_2 have respective lags of 16.7 sec. and 0.5 sec. Each corner is responsible for an ensuing gain reduction of 20 db. per decade. Although the experimental gain curve reduction does not start to occur until a frequency of about

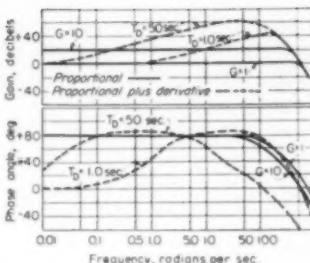


Fig. 4a—F.R. diagrams for a proportional, and a proportional plus derivative controller.

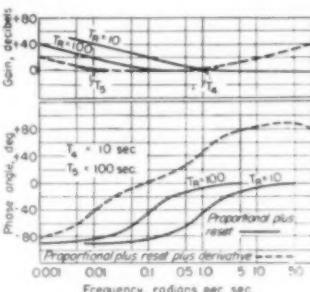


Fig. 4b—F.R. diagrams for a proportional plus reset, and a proportional plus reset plus derivative controller.

0.02 radians per sec. is reached, it is interesting to see that there has been a noticeable phase lag at much lower frequencies. Phase lag for an individual time constant is always self-evident before an appreciable gain reduction occurs. The ultimate phase lag is 180°, or 90° deg. for each corner.

In the case of the broken-line curve of Fig. 5a the capacity lags T_1 and T_2 again are 16.7 and 0.5 sec. respectively. The transportation lag T_{Tz} has a value of 5.0 sec. The gain curve for this case is identical with the gain curve without transportation lag. However, the phase curves are drastically different. The phase curve without transportation lag reaches a lag of 180° at an infinite frequency whereas the phase curve with transportation lag reaches a lag of 180° at a frequency of 0.22 radians per second. The diagram for the transportation lag process is typical of processes encountered in industry, as there is always some transportation lag associated with any control system.

A three-capacity process is illustrated in Fig. 5b. T_1 and T_2 are still 16.7 and 0.5 sec. respectively whereas T_3 is an intermediate value of 2.5 sec. Addition of the third time constant contributes an additional 90° of phase lag at

high frequencies and also a faster gain reduction (60 db. per decade) at high frequencies.

The processes illustrated in Figs. 5a and b are the same processes that are depicted by signature curves in Fig. 3. Curves A and C (Fig. 3) correspond to Fig. 5a, Curve B to 5b. (Thus, it is possible to establish a definite correlation between frequency response diagrams and signature curves.)

STABILITY DETERMINATION

The type of recovery curve obtained after a load change is important in most processes. A criterion for good control is that the area under the recovery curve should be a minimum. Furthermore, it has been found that the minimum area under a recovery curve is obtained when the amplitude of each succeeding cycle is approximately one-quarter of the preceding cycle. This type of recovery curve can be approximated from a frequency

response diagram when the open loop plots of the process and control loops have been combined. The open loop criteria for good control are a combined loop gain of 1.0 and a phase margin of 30 deg. (150 deg. phase lag). An open loop plot of the complete loop is obtained by simply adding the frequency response diagrams of the open control and process loops.

The criteria for "hunting" are also important. Hunting (continuous cycling) will occur if the input and output disturbances of the complete loop are in phase and if the gain is high enough so that the output amplitude is equal to or greater than the input amplitude. A phase lag of 180 deg. added to the 180 deg. corrective action which is inherent in all controller loops will satisfy the in phase relation and a gain of 1.0 will satisfy the desired amplitude ratio. Therefore, a circuit which has an open loop phase lag of 180 deg. for a given disturbance will propagate that disturbance if the gain is 1.0 or larger, and the open loop is closed.

CONTROLLER PLUS PROCESS

Fig. 6 illustrates the open loop frequency response diagram of a proportional response controller (Fig. 4a) added to a three-capacity process (Fig. 5b). From this frequency response diagram it is clear that a 30 deg. phase margin occurs at a frequency of 0.52 radians per sec. The combined gain curve crosses this frequency at a value of -24 db. To meet our criteria of optimum control, it is necessary to have the gain curve cross this frequency at a value of 0 db. This can be accomplished by raising the gain in the controller. Previously we stated that an increase in the controller gain did not affect the phase curve and only shifted the gain curve up. Thus, we would need a controller with 24 db. or a gain of 15.9 for good control. The frequency (cycles per second) at which 30 deg. phase margin is obtained is approximately equal to the frequency of the recovery curve.

Controllability is improved if the area under the recovery curve is decreased. Since the area is a function of the amplitude and period of the recovery curve, it is to our advantage to increase the frequency at which a 30 deg. phase margin is obtained and at the same time increase the gain of the controller.

The open loop frequency response diagram of a proportional plus derivative response controller (Fig. 4a) and a three-capacity process (Fig. 5b) is depicted in Fig. 7. Using our criteria for the desired recovery curve, we find now that our 30 deg. phase margin

occurs at a frequency of 2.4 radians per sec. when the derivative time is 1 sec. (solid-line curve). Also, the combined gain curve crosses this frequency at a value of -45 db. Thus we would now have a controller with a gain of 178. The addition of the derivative response has, therefore, fulfilled the conditions needed for improved controllability. It is interesting to note what happens when we change the derivative time in this case from 1.0 to 10.0 sec. The broken-line curves of Fig. 7 illustrate the addition of more derivative time and its effect on the combined open loop gain and phase curves. The 30 deg. phase margin now occurs at 4.2 radians per second, but our gain has decreased to 40 (32 db.).

Fig. 8 illustrates the open loop frequency response diagrams for a proportional response controller (Fig. 4a) and a two-capacity process with transportation lag (Fig. 5a). With the indicated time constants of the solid-line curves, a 30 deg. phase margin occurs at a frequency of 0.165 radians per second. This means that we can have a controller gain of only 2.8 (9 db.). It is immediately obvious that transportation lag is extremely detrimental to process control. An improvement (broken-line curves) will be discussed later.

There are other frequency response methods of obtaining optimum controller responses which are beyond the scope of this paper. One of the most widely used and advanced methods is the closed loop diagram based on the Nichols chart.⁸

FREQUENCY RESPONSE ADVANTAGES

This discussion has shown that two methods are available to measure process and controller characteristics and to determine the best controller adjustments on a process. What are the advantages of each? First, the step responses (Fig. 2) do not give as detailed information about the controller as do the frequency responses (Figs. 4-8). From frequency response we can find the ultimate gain of the controller (gain after reset) and the gain cut-off frequency. Furthermore, some controllers have actions which are not adequately described by the simple equations or by the step response.

Second, and even more important, the frequency responses of each component of a process and a controller can be added easily to obtain over-all performance. Specifically, the amplitude and phase curves of a diaphragm valve can be added to those of a heat exchanger, a thermal system and a controller. The over-all performance can then be predicted with surprising

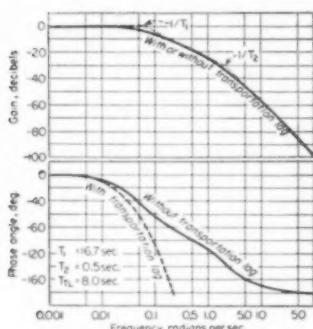


Fig. 5a—F.R. diagrams for a two-capacity process shown both with and without transportation lag.

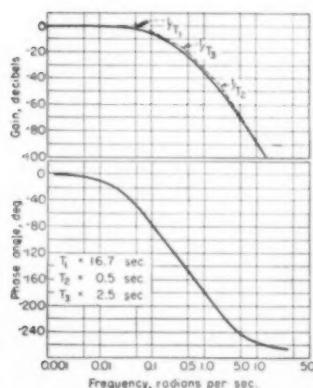


Fig. 5b—F.R. diagram for a three-capacity process. Note the three "corners."

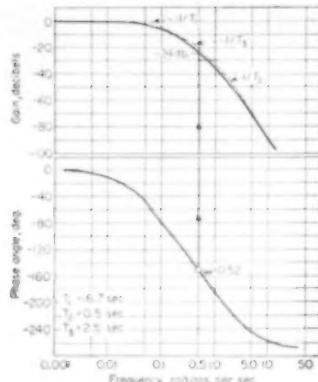


Fig. 6-F.R. diagram for a three-capacity process and proportional response controller. Note frequency of 30 deg. margin.

accuracy. While signature curves of process components can be computed to obtain an over-all curve, it is far more difficult and the results are less accurate.

On the other hand, the signature curve can be obtained more readily than the frequency response on a process or a controller. The usual process instrumentation can be used to obtain the signature curve, while the frequency response requires a sine-wave generator and a method of measuring gain (or attenuation) and phase lag. Thus it seems that both methods have a place in the kit of the instrument engineer, and that frequency response will supplement, rather than replace, the step response methods.

On any process there is no assurance that the signature curve, or the frequency response, will be the same at various control points and under all load conditions. Therefore, for precise work the signature curve, or the frequency response, should be obtained under extreme load and set-point conditions, and the controller should be adjusted for stability under the most difficult situation. In practice this is seldom necessary, for an examination of the process will often indicate where the most unfavorable results will be obtained. A signature curve, or frequency response, under this one set of conditions will determine the maximum safe controller adjustments and the performance of the controller on the process under the most adverse conditions.

This process performance is determined by two factors: (1) the controller responses and their adjustment, and (2) the type and size of the load changes. A load change is any process change requiring the repositioning of

the control valve which varies the flow of the controlling medium. In the heat exchanger, Fig. 1, typical load changes are steam pressure and liquid throughput variations. From the control standpoint, when the valve is wide open, the process is considered at 100 percent load; when it is half open, the load is 50 percent, etc. If load changes are sudden and large (e.g., 50 percent in 1 sec.) controller constants A, B, and C must be large in order to obtain good performance. If load changes are small (e.g., 5 percent), or gradual (e.g., requiring 1 hr.) the same good performance can be obtained with considerably lower values of A, B, and C. In fact, in some cases, the performance will be adequate without all three responses.

PROCESS IMPROVEMENT

In the preceding section we examined the benefits from addition of the derivative response to a controller. Even greater control improvements can often be obtained by a careful analysis of the process with the thought of reducing or eliminating the existing time constants. Let us consider the major time constants of the complete process of Fig. 1.

The Valve—The pneumatically operated valve introduces a capacity lag since time is required for its inflation and deflation. A smaller valve or a different valve of the same capacity might require a smaller motor which could be inflated or deflated more rapidly. In the case of large valves requiring large operators, a "booster" relay or a valve positioner will be helpful. These devices move the valve more rapidly and reduce its time constant. However, the added device introduces another time constant which is harmful. The frequency response diagram will show whether the device will improve the control or, instead, make it unstable.

If the frequency responses (or step responses) of a process are different at extreme load conditions, the valve characteristics should be examined. Possibly a "characterized" valve can be selected which will make the responses more nearly alike so that a given set of controller adjustments will be more suitable for all load conditions. This is particularly helpful when the controller would otherwise have to be adjusted to a low gain to be stable at one extreme condition.

The Heat Exchanger—The time constants of the heat exchanger can be decreased by reducing its mass, by increasing the heat transfer coefficient and by increasing the velocity of the throughput. Avoid an over-sized exchanger, a poorly vented steam side,

and keep the tubes free of corrosion and scale to keep the time constant smaller. For top quality performance, consider a pump to produce a high velocity and small time constant by recirculation.

Consider also methods of eliminating load changes and lags from the "tough" control problems. Specifically, if the load is changing rapidly on this heat exchanger, the control can be greatly improved by having the temperature of the output "reset" the steam pressure in the chest which in turn operates the control valve. The steam pressure "feels" changes in the incoming temperature and flow of the throughput long before the temperature sensitive element in the output, and makes an appropriate correction. This system, called a "pneumatic set" or a "cascade" control system, minimizes the effect of load disturbances on the temperature instrument. Fluctuations in steam supply pressure

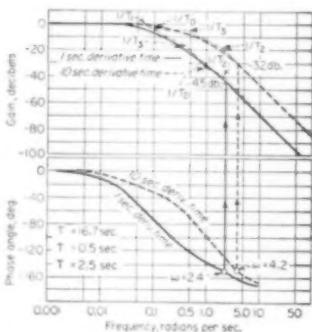


Fig. 7-F.R. diagrams for three-capacity process and proportional plus derivative controller with two derivative times.

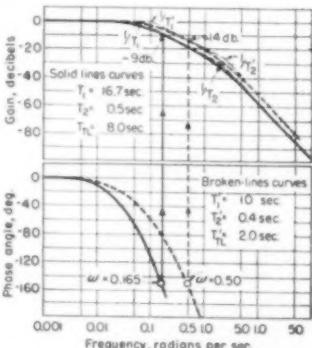


Fig. 8-F.R. diagrams for a two-capacity process with transportation lag, and a proportional response controller, before and after improvement.

(which would otherwise disturb the temperature sensitive element after a time interval) are sensed much earlier by the pressure sensitive device in the shell and are completely eliminated from the temperature control problem.

Another method of eliminating or minimizing the effect of load changes on the heat exchanger is by the use of steam pressure controller. This instrument addition is not as effective as the cascade instrumentation, but it does prevent load changes due to steam fluctuations. Since steam pressure variations are apt to be sudden, the controller can provide a real contribution.

Primary Measuring Element—Bare thermocouples, bare resistance thermometers, and bare thermal systems have short time constants. Of the three, only the bare thermal system is sufficiently rugged for general use and, hence, it offers the greatest possibility for improving process controllability. When a well is necessary for corrosion resistance or other reasons, the insertion of the sensitive element should insure close clearances and intimate contact.

Measurement Lag (Especially Important)—From the process standpoint, special attention should be given to the measurement lag associated with the sensitive element. Consider for example, the case of an element with an excessive thermal lag due to a large air gap inside the well. Relatively good performance might be apparent at the controller where indications and records are often obtained, yet the actual variations on the outside of the well might be excessive. In fact, when a "slow" thermal system is used on a "fast" process, actual temperature variations following load changes are many times the indicated values. Thus, it may be seen that we are looking at the process through "fogged" glasses—we really don't know what is going on.

While such sluggishness is most often associated with temperature measurement, the same phenomenon occurs when flow is measured by a mercury manometer. The inertia of the mercury and the resistance of the U-tube often cover up the rapid changes in pressure which occur across the orifice. In flow, this measurement problem has been solved by using aneroid (dry) or bellows type meters with low volumetric displacement. In temperature the problem is not easy, for the well cannot be eliminated for safety reasons, alone, in many industries. Probably the most satisfactory solution to the thermal lag problem so far is the primary element with an added derivative response. If the time

constant of the derivative response is set equal to the thermal lag of the sensitive element and the well, the signal to the controller approaches that which would be obtained if the well were not there. In conclusion, measuring lags must be short for two reasons: (1) to be able to control the process better, and (2) to know what the actual variable is doing.

Primary Element Location—Transportation lag is very detrimental to control, hence, the sensitive element must be placed as close as possible to the heat exchanger.

Temperature Transmitter and Tubing—The transmitter itself has a small time constant, but it is important for it can include a derivative response which will minimize the effect of the well's lag. The length of transmission tubing should be as short as possible to keep the transmission lag small. When long leads are necessary to centralize operations and information, consider the possibility of close-coupling the controller, and transmitting only the set point and the value of the controlled variable. This removes the transmission lags from the control circuit itself. Incidentally, transmission lags are small (1 sec./100 ft.) and are important only on "fast" applications.

Returning to Fig. 8, which is a frequency response diagram for a process, let us note how its controllability can be improved by applying the principle of reducing the time constant. The process of Fig. 8 is not as complicated as the heat exchanger since it has only three time constants. However, let us assume (solid-line curves) that the capacity lag of the heat exchanger is 16.7 sec., the capacity lag of 0.5 sec. is due to the pneumatic control valve and the dead time lag of 8.0 sec. is composed of a transportation lag of 4 sec. and a transmission tubing lag of 4 sec. For our purpose, let us assume that all other time constants are negligible.

REDUCING TIME CONSTANTS

To reduce the time constant of the heat exchanger, let us install a circulating pump which increases the velocity through the exchanger and reduces its time constant to 10 sec. To further reduce the transportation lag, move the temperature sensitive element closer to the heat exchanger so that the velocity distance lag is only 1 sec. At the same time, close-couple the controller with the transmitter and the valve motor so the tubing lag is 1 sec., making the total transportation or dead time lag 2 sec. Close-coupling the controller to the control valve will

probably reduce its time constant slightly to 0.4 sec. The broken lines of Fig. 8 show the open loop frequency response diagram of the improved process. The controller gain for a 30 deg. phase margin is now 5.0 (14 db.) and the frequency is 0.50 radians per sec. As a result, the control variable will not be disturbed as much by a load change and it will return to the desired value much more quickly. In fact, if it is important, a very close approximation of the recovery curve can be calculated by frequency response methods.

In conclusion, step response and frequency response diagrams provide methods of conveying process information to the instrument engineer. The diagrams should be obtained at extreme set-point and load conditions. In reverse, these same diagrams allow the instrument engineer to describe fully the controller, valve, and sensitive element performance to the process engineer. Even more important is the fact that the frequency response diagrams can be combined readily to predict the performance of a control system on a process without making the actual installation and testing the complete assembly. Thus, the effect of design improvements can be predetermined and the costly trial-and-error method eliminated.

We have also seen that if only the time constants of a piece of equipment are known, a reasonably accurate frequency response diagram can readily be constructed and the performance of the process with a given controller, valve, and sensitive element can be predicted. Even the best controller settings are determined. Thus, the instrument engineer has powerful tools at his command, but it must be recognized that they can be used only if process information is available.

Eventually, it can be predicted that frequency response information will be supplied by the manufacturer for simple pieces of equipment. With this and the frequency response of controllers, the task of applying instruments to processing equipment will be greatly facilitated.

REFERENCES

1. Ziegler, J. G., and Nichols, N. B., *Trans. A.S.M.E.*, 1941.
2. Chestnut, H., and Mayer, R. W., "Servomechanisms and Regulating System Design," Vol. I, John Wiley & Sons Co., New York, 1951.
3. Brown, G. L., and Campbell, D. P., "Principles of Servomechanisms," John Wiley & Sons Co., New York, 1948.
4. Caldwell, W. L., "Single Knob Adjustment of Reset Rate and Gain, I.S.A. preprint, 1951.
5. Abredt, W. R., and Taplin, J. B., "Automatic Feedback Control," McGraw-Hill Book Co., Inc., New York, 1951.
6. Caldwell, W. L., "Frequency Response Analysis, Taylor Technology," 4, No. 3 (1951).

Process Control by End-Point Analysis

Modern operations demand immediate and continuous knowledge of composition of process streams. Laboratory instruments have moved into key plant functions.

W. A. PATTERSON and J. M. DEVINE

End-point analysis, or process control by analysis of the product, is successful only when analytical results can be obtained in a minimum of time. The ideal is a method of continuous analysis which gives an instantaneous indication of variations in the quality or composition of the product.

In the past, plant operators would have settled for end-point analysis alone, making operating corrections manually. But modern industry also demands automatic control of the variables. This is normally done through a separate mechanical or electronic brain in conjunction with the analytical instrument. However, in their more advanced development, certain of the analytical instruments to be described here, when properly applied, can perform both functions.

Analysis of a mixture for a given component is based upon some property of that substance. There are a large number of such properties, but they may be listed under seven classifications: chemical, mechanical, thermal, electrical, magnetic, optical and nuclear.

Mechanical, thermal, electrical and magnetic properties usually are not highly specific, though the easiest to develop into reliable instruments. There are exceptions (for example, the paramagnetism of oxygen), but in general these properties, when measured in a mixture, are a summation of all those in the mixture and are not characteristic of the individual components. On the other hand, many of

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the optical, nuclear and chemical properties are very specific, though such instrumentation often is complicated and expensive or has other bad features.

Industrial needs have given great impetus to the development of instruments of high selectivity. This has been the most significant development in recent years. In particular, instruments based upon spectroscopic principles have obtained wide acceptance, and their potential seems unlimited. In addition, ingenious arrangements have been devised to combine the high selectivity of chemical reactions with other techniques which are more readily adapted to instrumental measurement.

Since progress in end-point analysis has largely paralleled that of instruments with high selectivity, the major part of this article is devoted to such instruments. On the other hand, there have also been significant developments in instruments based upon non-selective properties. These, because of their relative simplicity, are still the mainstay of many simple processes and will continue to retain their usefulness in the future. Discussion, however, will be limited to those which appear to be the most important or have shown significant changes in recent years.

For purposes of this article, the different instruments are classed as non-selective, of limited selectivity, and selective.

Depending upon the circumstances, non-selective instruments can give very specific results; for example, in a two-component mixture. But, in general, the property being measured is not an especially distinguishing property of the substance in question.

DENSITY AND SPECIFIC GRAVITY

Measurements of density are still generally based upon the hydrometer, though excellent instruments using other principles are available. In the hydrometer types an electromagnetic pick-up is the usual device for locating the exact position of the hydrometer bulb.

One instrument of especial interest, the Densitrol (Precision Thermometer & Instrument Co.), uses a floating

plummet weighed with a hanging chain attached to the side of the vessel. The operation is thus similar to the Chainomatic balance. For this instrument, sample flow rate may vary from 0.1 to 0.5 gpm. without affecting the readings, and sample streams may be under pressures up to 500 psi.

One type of density meter weighs a constant-volume sample in a bulb attached to a lever arm and scale. It is especially useful for controlling operations in which two liquids are blended to a desired composition. Another type embodies two tubes of different lengths dipping into the liquid. Air or water is bubbled through the tubes, and the difference in pressure between the two tubes is a function of the density of the liquid. This instrument is especially useful with mixtures containing solid particles or fluids having poor flow characteristics.

A further type is claimed to record accurately and continuously the changing gravity of a gas to three points in the fourth decimal place. It operates on the principle of equalizing the buoyant effect of the gas in comparison with air, by adjusting the pressure in the sample chamber. It automatically corrects for variations in barometric pressure and temperature.

VISCOITY

Viscosity is gradually being recognized as one of the most fundamental properties of matter. Where viscosity has a direct bearing on the quality of the product, the viscosimeter must be carefully selected. While there are innumerable laboratory viscosimeters which are not adaptable to process control, there are others which are very useful for this purpose and may be used for continuous or fairly rapid intermittent measurements.

The first of these (Norcross) employs an orifice at the end of a cylinder, with a 2 to 6-min. cycle for filling the cylinder and expelling the fluid through the orifice by means of a piston. The time required is recorded on a chart.

The Viscorator (Fischer & Porter) is based on the rotameter principle. The fluid flows through a typical rotameter tube containing two floats, one of which is highly sensitive to vis-

cosity changes and the other virtually insensitive. The latter is used to adjust the flow to a constant value so that the first float gives the viscosity measurement. The application of both of these viscosimeters would be to Newtonian liquids.

A third instrument, the sonic type (Rich-Roth), is simply a vibrating disk, the loss of energy by the damping of the vibrations being a measure of the viscosity. This one is relatively new and as yet has not been widely applied. It can be readily applied to any liquid simply by inserting the disk in the side of the containing vessel. The high-frequency vibration used, however, can modify the characteristics of the material, and this may have to be guarded against if it is of consequence to product quality.

Finally, there is the spindle type (Brookfield Engineering Laboratories). The spindle is rotated at a constant speed, and the drag on a coiled spring attached to the motor shaft and spindle is a measure of viscosity.

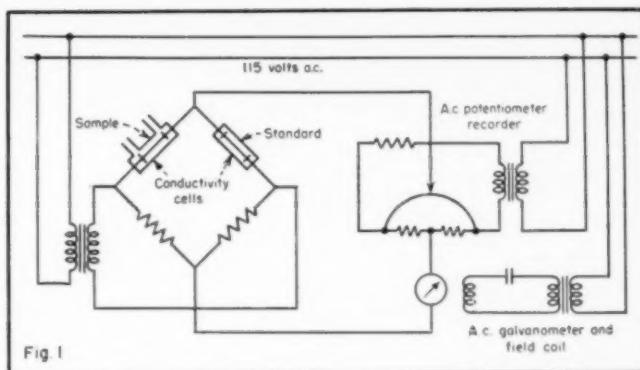
This type, depending upon speed of rotation and design of spindle, is applicable to wide ranges of viscosity problems and is especially useful for non-Newtonian fluids. The instrument is not affected by temperature and thus can be used on hot materials. Another advantage is that readings are given directly in centipoise units.

Typical problems where viscosimeters are applied in end-point analysis are in controlling polymerization reactions, controlling the addition of solvents to printing inks, and in the preparation of textile sizing solutions.

REFRACTIVE INDEX

While refractive index is a very specific property of a pure substance, a measurement on a multi-component mixture is an average of components present. Therefore, refractometers are classed as non-selective instruments. However, the precision of refractive index measurements offers strong inducements to their use in process control, and continuous automatic recording instruments are now commercially available.

The Robomatic (Precision Scientific Co.) is offered with controlling elements. It is essentially a dipping refractometer, in that the liquid surrounds the prism. Monochromatic light is passed along the sample-prism interface. Some of it is refracted through the glass prism, forming a light-dark field on an eye-piece as well as on a narrow slit mounted in front of a movable photomultiplier tube. Arrangements are provided whereby the phototube assembly is caused to move up or down in accordance



GAS ANALYZER measures thermal conductivity of the sample.

ance with the light-dark interface, and an associated pen-and-lever mechanism affords a permanent record of variations in the refractive index.

Another type of refractometer is based on the principle that refractive index is related to the intensity with which light is reflected from the interface of two materials. This offers a number of advantages: (1) The response of a photoelectric cell, varying with the intensity of light, can be readily adapted to recorders and controllers; (2) it is applicable to either transparent or opaque materials; and (3) measurements can be made simply by installing a prism in the side of the flow line. The use of an additional prism against a standard liquid permits the use of a bridge circuit, providing differential measurements with resulting greater accuracy. This instrument is not yet commercially available.

A simple non-recording refractometer (C. A. Brinkmann & Co.) can be inserted in the side of process vessels. Light refracted from the fluid results in a light-dark interface on a viewing screen. This instrument is recommended mainly for measuring the concentration of solid matter in fruit juices, jams, organic liquids and pulps.

Thermal CONDUCTIVITY

Dependence of the temperature, and hence the electrical resistance of a heated filament, on the thermal conductivity of the atmosphere surrounding the filament has been known for a long time, and many useful gas analyzers are based on this principle. Recent advances have been directed at improving the accuracy and reliability of the results.

In all instruments the filament resistance of the sample cell is compared in a wheatstone bridge circuit with

that of a reference cell filled with a standard gas, as shown in Fig. 1. The standard gas may or may not be saturated with water vapor. By using this reference cell for a second gas stream, differential analysis is possible.

Remote indicating devices have been developed with automatic compensation for leads of various length between sampling points and indicator. One such unit (Gow-Mac Instrument Co.) can be switched to any number of thermal conductivity units for multiple sampling.

Thermal conductivity instruments have been applied to determinations of ammonia, sulphur dioxide, oxygen, hydrocarbons, hydrogen sulphide, helium and argon. Most commonly, however, they are used for determination of carbon dioxide.

These instruments are also especially useful for the determination of hydrogen. Here the very high conductivity of hydrogen relative to other gases makes it almost a selective measurement.

HEAT OF COMBUSTION

Catalytic combustion gas analyzers determine the composition of a combustible gas mixture by measuring the temperature rise caused by combustion at the surface of a heated platinum filament. Like thermal conductivity instruments, measurement is based on the change in electrical resistance relative to a comparison filament.

However, new problems arise, such as instability due to zero drift. This is overcome in a new type (Davis Emergency Equipment Co.) in which a thermocouple is used in conjunction with each filament. The circuit is shown schematically in Fig. 2. The thermocouples are connected in opposition, so that they measure the difference in temperature of the two fila-

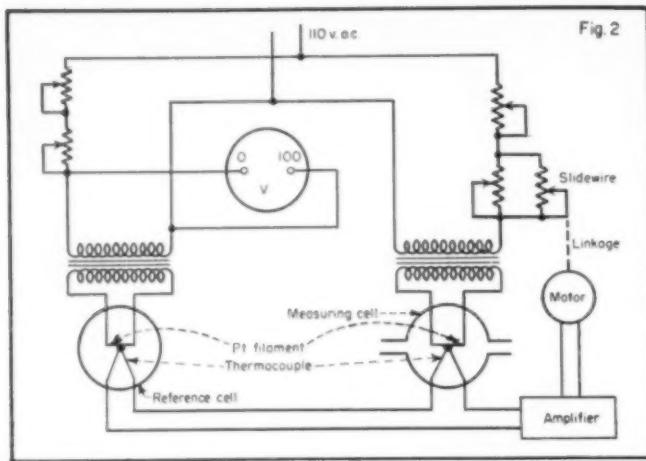


Fig. 2

COMBUSTIBLE GAS analyzer, feedback thermocouple type.

ments. A variable resistor in series with the power supply to the sample filament is driven by a servomotor so that, as the temperature of the filament tends to increase, owing to combustion at its surface, the current through it is decreased to keep it at the same temperature as the reference filament.

Combustion analyzers are applicable to many kinds of gases and over wide concentrations. It is apparent that an excess of oxygen is required, and for high concentrations it is necessary to dilute the sample with fixed proportions of air or oxygen. The reverse procedure can also be used to measure oxygen concentration.

DIELECTRIC CONSTANT

The dielectric property up to the present has not had general application for end-point analysis, although it is considered in some quarters to have greater utility than a number of other more widespread techniques. To some extent such applications may be awaiting the development of compact, relatively simple, stable variable-

frequency oscillators. For, except for a few materials with very high dielectric constants, such as water, the actual dielectric measurement must be very accurate. While this can be readily done in the controlled conditions of research laboratories, it becomes more difficult under plant conditions.

Two types of continuous measuring dielectric-constant meters are available. The first uses two capacitors in a single oscillating circuit. One capacitor is used for the material and the other forms part of a bridge circuit. As the dielectric of the material changes, the vibration frequency of the circuit also changes. In order to balance this effect, the capacitance of the other condenser is tuned in the opposite direction, and this motion is automatically followed by a recorder.

A second type of instrument employs a single capacitor. As the oscillating frequency changes with the dielectric constant of the material being measured, it is mixed with that of a constant-frequency oscillator in such a way that the difference in frequency is obtained by a frequency meter.

Dielectric-constant devices have been applied mainly to oxygenated compounds which have high dielectric constants. While applications to liquid streams have been made, most are to solid materials, such as cotton, paper and coatings. A special application is in the measurement of the moisture content of granular materials.

pH, OXIDATION-REDUCTION POTENTIAL AND ELECTRICAL CONDUCTIVITY

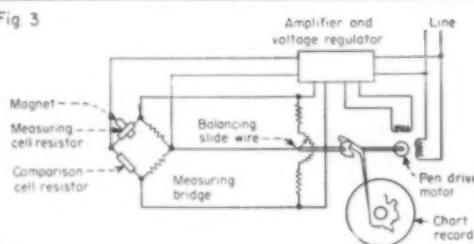
These three measurements are old standbys in process control and all are based on the behavior of an electrolyte when subjected to certain electrical procedures.

Determinations of pH for the control of active acidity are probably the most common of all process control procedures, being readily adaptable to automatic and continuous recording. Electrometric measurement of pH is based upon the principle that certain types of electrodes, when immersed in an aqueous solution, develop an electrical potential which depends upon the concentration of hydrogen ions in the solution. The most important of these for industrial use is the glass electrode. A reference electrode of constant potential, regardless of conditions, is needed, and the calomel electrode appears to be ideal for this purpose. The electrical potential between the two electrodes is amplified and recorded.

Recent developments have featured electrodes of entirely waterproof construction and electrode assemblies which can be immersed directly in reaction vessels, without the necessity of sampling lines. Also, an improved glass electrode can be used up to pH 14.

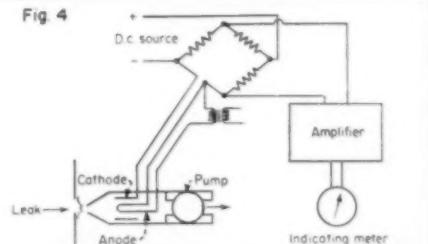
Oxidation-reduction potentials are not so widely used. They depend upon the fact that a suitable non-reactive electrode, when immersed in a solution containing oxidized and reduced ions in equilibrium, takes on a potential which depends on the relative concentrations of these ions. The usual electrode is made of platinum

Fig. 3



OXYGEN analyzer, temperature-dependent type.

Fig. 4



HALOGEN detector, used to find very small leaks.

or gold, and here again the calomel reference electrode is used.

Electrical conductivity is a measure of the current-carrying ability of all ions in solution. It is expressed as the conductance in reciprocal ohms (mhos) between two electrodes exactly 1 cm. square and 1 cm. apart. The conductivity cell forms one arm of an a.c. bridge. The electrodes are usually platinum coated with platinum black and are usually in a glass or hard rubber envelope.

Electrical conductivity measurements would be useful in any process

where there is a significant change in the number or type of ions present in a solution, the types being distinguished by their relative speeds of migration. This, however, is appreciable only for hydrogen. Its application becomes unique, however, in determining the purity of water, in that the conductivity is directly proportional to the ion content for low ion concentrations. Some instruments are calibrated to zero for pure water and read directly in terms of impurity content within the range 0 to 30 ppm. of sodium chloride.

Partial or Limited Selectivity

Instruments of limited selectivity, owing either to the property being measured or to the procedure used, give specific results even in multi-component mixtures.

PARAMAGNETISM AND DIAMAGNETISM (OXYGEN)

It has already been shown that oxygen can be measured by combustible gas analyzers. The special magnetic properties of oxygen can also be used to determine oxygen content of gases. Oxygen is strongly paramagnetic; that is, magnetic lines of force pass through it more readily than through a vacuum, while most other gases which might be found in an industrial mixture are slightly diamagnetic.

Two instruments are available based on this principle. One of them (Arnold O. Beckman) consists of a dumbbell-shaped glass test body and mirror mounted on a silica torsion fiber, perpendicular to axis of the dumbbell. The dumbbell rotates in an inhomogeneous magnetic field, its rotation being observed by a standard lamp and scale. Sensitivity is high; full scale corresponds to a change in the partial pressure of oxygen from 0 to 20 mm.

A second type of instrument (Hays) depends for its operation on the fact that oxygen becomes less paramagnetic as its temperature rises. The measuring and comparison cells, each containing a glass-covered platinum resistance element, together with fixed resistors form the arms of a wheatstone bridge. The circuit for this instrument is shown in Fig. 3.

The measuring cell has tapered pole pieces in opposite walls. An Alnico magnet supplies a strong field between them. As oxygen enters the cell, it is heated by the platinum resistor and becomes less paramagnetic. As a result it is displaced by cool, strongly magnetic oxygen. The con-

tinuous circulation cools the resistor, its resistance decreases and the wheatstone bridge unbalances. The unbalance is amplified and recorded as percent oxygen.

Analyzers of this type can also be used for nitric oxide, which is correspondingly very highly paramagnetic compared to most other gases.

MERCURY, HALOGEN AND SMOKE CONCENTRATION

Operation of the mercury detector (General Electric) is based on the absorption by mercury vapor of the 2,537 Å resonance line emitted by a low-pressure mercury vapor lamp. Air containing the mercury vapor is passed through a cell with quartz windows, situated between the lamp and an ultraviolet-sensitive photoelectric cell. A bridge amplifier is used and results shown on a meter calibrated in terms of mercury concentration.

The instrument is sensitive to 0.03 mg. of Hg per cu. m. of air. It shows some sensitivity to organic impurities in the air which have absorption bands in the 2,537 Å. region. The effect of these can be readily checked.

A chemical method is based on the darkening of selenium sulphide-impregnated papers by mercury vapors and comparison with standards. This method can provide an integrated result over a period of time, the vapors being brought into contact with a rotating disk containing the selenium sulphide.

An instrument has been developed (General Electric) for the detection of halogens and compounds containing them, based on the fact that there is a marked increase in thermionic emission when the air surrounding the electrodes contains these compounds (Fig. 4). According to claims, it is sensitive enough to detect leaks equivalent to 0.01 oz. of Freon escaping per hr. It is primarily used as a leak detector.

Measurement of the intensity of smoke, fog and mist concentration is of considerable importance and can be done simply with the use of a light source, a suitable cell which samples the air, and a light detector. A typical instrument uses a sealed-beam spotlight at one end of a slotted tube and a sealed-beam bolometer at the other end.

HUMIDITY

Measurement of humidity is of considerable importance and is essential in many industrial processes. Where the moisture content is very critical, as in refrigerating gases, resort is made to chemical methods to obtain the required accuracy. In the case of Freon, infrared absorption spectroscopy has been useful. These are not continuous or automatic methods, however, and any instrument advancement in humidity measurements, either to less complicated apparatus or to greater accuracy, is always welcomed. Among the widespread uses of humidity control that might be considered as part of endpoint analysis are the processing and packaging of hygroscopic materials, checking the efficiency of drying systems, controlling the moisture content of furnace atmospheres, and processing of ceramics.

Other than chemical methods, the dewpoint method is probably the best standard for humidity determinations. The gas to be tested comes in contact with a metallic mirror to which a thermocouple is attached. The mirror is cooled by directing a stream of cooling gas, such as carbon dioxide, against its back. Flow of cooling gas is increased until a spot of moisture condenses on the cooling surface. Slight increase or decrease in the flow of cooling gas will cause alternate condensation and evaporation of moisture, and this is observed through an inspection window in the sample chamber. The dewpoint temperature is read directly from an indicating instrument.

This is a manually operated instrument. It has, however, been developed into a continuous recording instrument by the following modifications. Formation of the dew spot is measured by a light beam reflected from the surface of the mirror to a photoelectric cell. A refrigeration system produces a constant flow of gas against the back of the mirror. A heater mounted behind the mirror raises the temperature of the mirror to the dew point. The amount of light reflected to the photocell controls the heater, and there is a steady cycle between dew formation and re-

removal, the maximum amplitude of which is about 2 deg. F., regardless of the actual temperature being recorded from ambient to -90 deg. F.

The electro hygrometer (American Instrument) works on a much different principle. It consists of a polystyrene cylinder doubly wound with wire. This is coated with partially hydrolyzed polyvinyl acetate containing a small percentage of lithium chloride.

Since lithium chloride is hygroscopic, it gains or loses moisture until it is in equilibrium with the partial pressure of water vapor in the atmosphere around it. This, in effect, makes the electrical conductivity of the film a function of the relative humidity of the atmosphere, which can thus be determined by measuring the electrical conductivity. The range of relative humidity determined depends on the lithium content of the coating, and for maximum accuracy eight elements are used to cover the range 7 to 100 percent relative humidity. Indicators,

controllers and recorders are available for this instrument.

The Dewcel (Foxboro) is an ingenious modification of this instrument but operates on a different principle. Basically, the idea is that the partial pressure over a saturated lithium chloride solution is in equilibrium with the partial pressure of moisture in the air at the same temperature. Below this temperature moisture would condense from the air, and above it moisture would evaporate from the solution. In the first case some lithium chloride would go into solution and in the second it would crystallize out.

It is thus similar to the dewpoint method using cooled mirrors, but the vapor pressure above the saturated lithium chloride solution is much less than that for water at the same temperature. Thus the lithium chloride solution can be operated at much higher temperatures, and refrigerants are not needed except at very low humidities.

Fully Selective Instruments

Properties measured by these instruments are specific in nature and will usually differentiate the substance in question from other components in a mixture. There are two general types—those based on chemical reactions and those purely physical in nature.

CHEMICAL PROPERTIES

Some instruments are based upon the sensitivity of a chemical reaction, combined with a physical technique for automatic recording of the result. For example, the sensitivity and accuracy of determining carbon dioxide in a mixture of gases by thermal conductivity (a physical method) can be greatly increased by comparing the conductivity of the original sample with that of a sample from which the CO₂ has been absorbed (a chemical technique). It is apparent that this could be done by running the gas through one conductivity cell, then through the absorber (solution of barium hydroxide), and then through the comparison cell. This is a type of differential analysis.

A refinement on the thermal conductivity method for CO₂ gives good results for carbon monoxide in the presence of CO₂. The latter is removed by a potassium hydroxide-Ascarite absorber, and the CO converted to CO₂ by passing it over hot iodine pentoxide. Concentration is measured in the thermal conductivity cells. Problems that have to be overcome are maintenance of constant

flow rates of sample and absorbing solution and the thermostating of conductivity cells. Replenishing of reagents is also necessary, but this can be done at prolonged intervals by using auxiliary tubes in parallel which can be switched into the circuit.

Determination of hydrogen sulfide in a mixture of carbon monoxide, hydrogen and inert gases illustrates still another technique. Here the gas is brought in contact with a piece of cloth impregnated with lead acetate. The HS reacts to form black lead sulphide; the exposed area of cloth is illuminated, and the reflected light measured by a photo-

cell. A similar area of illuminated unexposed sample and second photocell act as a control. A recorder measures the difference in output of the two photocells. The cloth strip can be advanced at fixed intervals to expose unused sections.

Automatic titration would be very desirable for process control but, in general, laboratory developments of this nature have been too complicated for plant use. However, one instrument (Consolidated Engineering) seems to have possibilities. Its schematic diagram is shown by Fig. 5. It has been developed for the automatic titration of mustard gas with bromine, but may be used for any sulphur compound.

The gas is bubbled through an acidified potassium bromide solution in the titration compartment and the reactive sulphur compound absorbed. The titration compartment is also an electrolytic cell which produces bromine for the titration. This is controlled by the potential between a platinum electrode in the titration compartment and a calomel electrode in an outer compartment; the electrolysis titration is carried out by a second platinum electrode in the titration compartment and another in the outer compartment. When there is an excess of sulphur in the titration compartment the potential rises, causing an increased current to a d.c. amplifier. The output of the amplifier operates the electrolysis system, causing more bromine to be produced.

Several attempts to adapt standard chemical procedures to continuous operation have been made on the standard Orsat gas analyzer. This is carried out by a discontinuous batch sampling technique which operates on a 2 to 3-min. cycle.

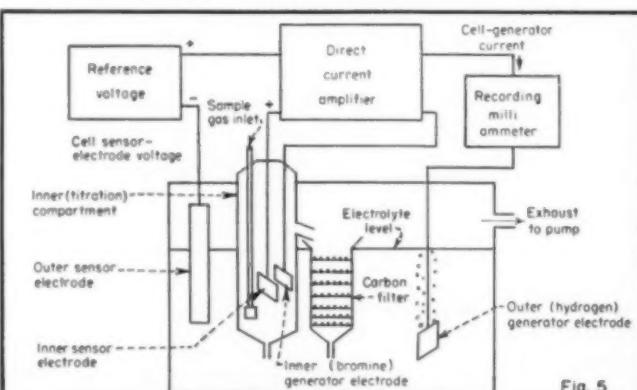
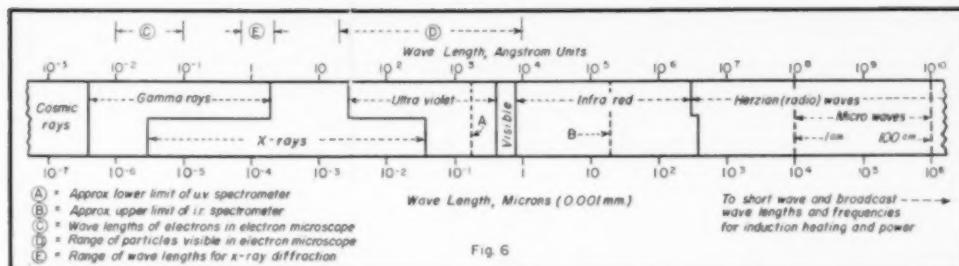


Fig. 5

AUTOMATIC TITRATION for sulphur compounds involves bromine electrolysis.



ELECTROMAGNETIC SPECTRUM ranges used in analytical instruments.

The Thomas Autometer (Leeds & Northrup), a special instrument for the determination of sulphur dioxide in air, employs electrolytic conductivity as the physical technique. A continuous sample is passed through an absorbing tower counter-current to a hydrogen peroxide-sulphuric acid solution; the SO_2 is absorbed and converted to the sulphate ion. The solution is then passed to an electrolytic conductivity cell and the result recorded in ppm. SO_2 on a recorder by comparison with the conductivity of the solution before absorption. Impurities such as oxides of nitrogen, HCl , H_2S , and ammonia can cause interference, though hydrocarbon gases and CO_2 do not. Results can be obtained continuously or integrated over 30-min. intervals. The instrument is reputed to be accurate to 0.1 ppm. SO_2 .

PHYSICAL PROPERTIES

End-point analysis generally requires the measurement of a unique property of the material, if the system is multi-component. Since present-day scientific techniques facilitate the study of the electromagnetic spectrum in great detail, certain instruments known generally as spectrometers have been established as tools for studying characteristic properties of materials arising either from the emission or absorption of radiation. These instruments are based upon measurement of the following characteristics:

1. Emission of ultraviolet and visible light.
2. Absorption of ultraviolet radiation.

3. Absorption of visible radiation.
4. Absorption of infrared radiation.
5. Raman phenomena.
6. Molecular mass.
7. X-rays: absorption and diffraction.

8. Electron diffraction.
9. Electron microscopy.
10. Absorption of microwaves.
11. Fluorescent phenomena.

Greatly simplified, a portion of the electromagnetic spectrum of interest in a discussion of these instruments is presented in Fig. 6.

EMISSION RADIATION

Instruments employing radiation given off by the material being measured are classed as emission spectrometers. They are used extensively in the chemical field for the intermittent testing of process raw materials and products, but their development for process control has reached its highest level in the metallurgical field, where direct-reading spectrometers are not uncommon. A typical instrument of this type (Baird) is currently being utilized to analyze ferrous and non-ferrous alloys. In 1 min. this instrument yields quantitative results on 12 elements in an alloy sample.

Fig. 7 illustrates the basic diagram of a simple spectrometer. Energy from the source passes through a slit and falls on a prism, which can be made of various materials, depending upon the region of the spectrum studied. The dispersed radiation is either recorded on a photographic plate or detected by means of photo-sensitive tubes.

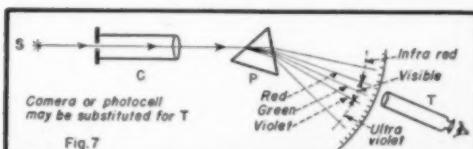
A very simple instrument has been developed especially for determination

of sodium and potassium. The solution containing the sodium or potassium ions is sprayed into a bunsen burner flame and the sodium and potassium spectral lines emitted are isolated by either a spectrometer or a filter photometer. Intensity of the radiation obtained is observed by a photoelectric cell and recorded on a meter. This instrument has received wide use in laboratories and offers possibilities for process streams.

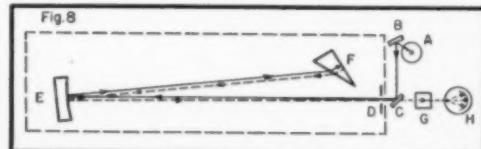
ABSORPTION OF RADIATION

Instruments of this type employ a separate source of radiation, which is transmitted or reflected by the substance under examination, and measure the resulting intensity of the affected radiation. For ultraviolet and visible light quartz prisms are generally used, although glass is often used for visible; sodium chloride or potassium bromide prisms are used for the infrared region. Most of these instruments require intermittent calibration to check variations in electrical and optical stability and in the concentration working curves. Elaborations in some instruments eliminate some of these adjustments and reduce others to a minimum.

Absorption spectroscopy in the ultraviolet range is of considerable interest in the field of aromatic and unsaturated aliphatic compounds which have absorption bands in this region. Such bands are very sensitive and are very useful for the detection of traces of benzene vapors in air. Instruments utilizing quartz prisms and interchangeable photoelectric cells and light sources cover a wavelength range from 2,200 Å. to 1 micron.



SIMPLE SPECTROSCOPE (7) and quartz spectrometer (see Chem. Met. Eng., July 1945, p. 120).



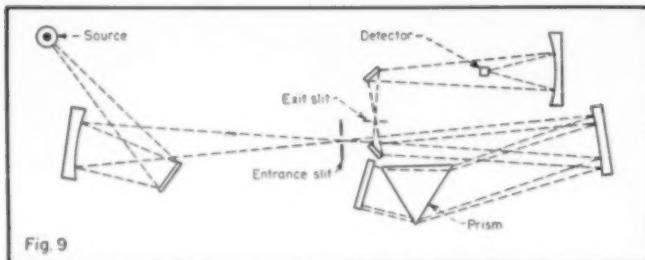
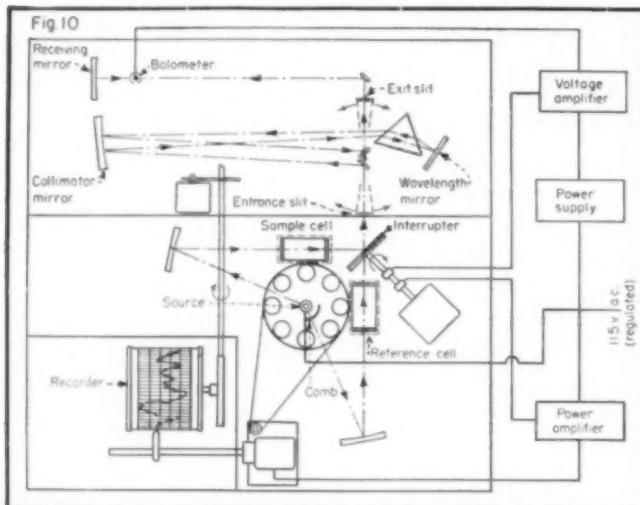


Fig. 9

INFRARED SPECTROMETER with single-beam optical system.



INFRARED SPECTROMETER using two beams of radiation.

The optics of a typical instrument (Beckman) are shown in Fig. 8. By setting this kind of instrument at a single wavelength, it can be used for continuous analysis and control of flowing liquid and gas streams. Typical applications for process control range from the determination of butadiene to some of the vitamins.

Techniques pertaining to the study of visible radiation do not differ fundamentally from that of the ultraviolet region, except that, being perceptible to the human eye, visible radiation involves color and therefore becomes of interest for colorimetric purposes.

Instruments of this class are so satisfactory that highly quantitative accuracy is possible. Performance of these spectrometers has led to the rather extensive application of filter photometers or colorimeters, which study certain desired portions of the spectrum without requiring dispersing mediums such as the prism.

Usefulness of the visible region in

process control is restricted, in that, for the majority of substances, chemical reactions must be introduced to provide colored components. In spite of this, methods are being developed for this type of application.

The infrared region is one of the most useful for identifying chemical groups. This is due to the fact that absorption bands in the infrared region arise from molecular vibrations which center about specific atomic groupings within a molecule. Although the infrared region extends from the visible to 300 microns, its useful range, due to instrument limitations, extends only to 38 microns.

While infrared spectroscopy depends upon the same general optical principles as the ultraviolet and visible regions, methods and techniques differ greatly. Because of the difficulty of transmitting infrared energy, rock salt or fluorite optics and reflecting mirrors must be used. Different methods of measuring energy are re-

quired, since photocells and photographic films are insensitive in this region. Instead, extremely sensitive thermocouples or bolometers are used in conjunction with extremely high gain amplifiers or sensitive galvanometers.

Optical systems of infrared spectrometers are of two general types—the single-beam instrument utilizing the system illustrated in Fig. 9 (Perkin-Elmer), or the null type, illustrated schematically in Fig. 10 (Baird).

The latter instrument employs two beams of radiation from a single source, a spectrometer, fast detector and high-speed recording system. The sample and reference beams are alternately chopped at 10 cycles per sec. at the entrance slit to the spectrometer. The amplified a.c. signal on the detector is used to drive a variable comb diaphragm in the reference beam. The spectra are registered on a recorder by a pen mechanically linked to this comb.

Infrared spectroscopic applications include: Determination of raw material or product purity by the measurement of minor components or trace substances; multi-component analysis in gas, liquid or solid states; determining structural qualities; and controlling and observing the progress of a reaction involving only one infrared absorption band.

CONTINUOUS INFRARED ANALYSIS

A recent development that is gaining widespread attention in the field of process analysis and control is the use of non-dispersive analyzers utilizing filters instead of dispersing mediums. These instruments measure the integrated energy of all of the spectral bands of the material, instead of selecting a single band for the analysis. Since the filter used to isolate the particular bands is the actual material being measured, these instruments may be said to have an infinite resolution with zero dispersion. The result is an extremely selective instrument of relatively simple design.

Fig. 11 illustrates the two general types of non-dispersive analyzers currently available. It is common practice to employ in both types a sample cell, a filter cell, a compensator cell, and an interference cell in sensitizing the instrument to one component and de-sensitizing its response to all other components in the mixture.

Fig. 11 (b) shows the negative type of instrument (Baird). In sensitizing this type to a particular analysis, it is customary to place the component for which a measurement is desired in

the filter cell. The other components are placed in the compensator cell. Mixtures of nitrogen and background gases are placed in the interference cell. The radiation is detected by two bolometers or thermopiles in a bridge circuit.

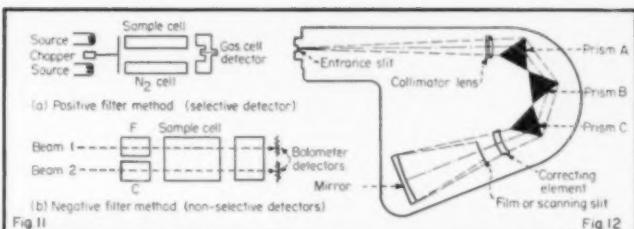
Fig. 11 (a) shows the positive, so-called Luft type of instrument (Mine Safety). Here the two beams of energy, after passing through sample and reference gases, are caused to fall on opposite sides of a cell which is divided into two compartments by a thin diaphragm. This diaphragm forms one plate of a condenser, which is filled with the gas to be measured. If energy of the proper wavelength falls on the receiver, the gas expands, resulting in a capacity change which is a measure of concentration.

Some of the more common applications of non-dispersive analyzers include the measurement of acetylene, butane, isobutane, carbon monoxide, carbon dioxide and ethylene. The uniqueness of infrared absorption bands permits the application of this type of instrument to the measurement of practically any infrared-absorbing compound in a plant stream. Application of these instruments is still in its infancy, and their potentialities seem unlimited, especially if developments now under-way on analogous instruments for liquid streams are successful.

RAMAN PHENOMENA

Raman spectroscopy gives essentially the same type of result as infrared absorption spectroscopy, in that it depends on the vibrations between atoms. The technique is to illuminate the liquid or solution being measured with intense monochromatic light, usually the 4,360 Å. mercury line. This incident radiation is modified by the molecules being examined and re-emitted as radiation of longer or shorter wavelength. This radiation is taken at right angles to that of the incident beam and is passed into a spectrometer and dispersed into a spectrum. The record shows up as a strong central image corresponding to the incident radiation with a series of lines on each side of it which are characteristic of the material. The positions of these lines can be used for qualitative analysis and their intensity for quantitative analysis of the sample.

Advantages over infrared absorption spectroscopy are that the spectra are sometimes simpler than those in the infrared. This makes it possible to measure as many as nine hydrocarbons in one mixture, using modern instruments, with automatic recording and



NON-DISPERSIVE infrared analyzers, positive (11a), and negative (11b); Raman spectrometer, basic optical system (12).

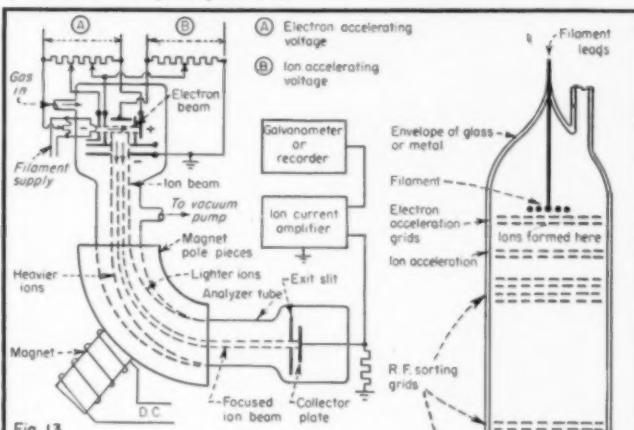


Fig. 13

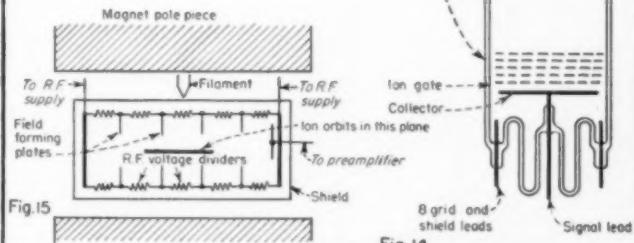


Fig. 14

MASS SPECTROMETERS—Conventional magnetic type (13); Bennett radio-frequency type (14); ion-resonant type (15).

photoelectric cell detectors. A further advantage is that water solutions can be used.

However, techniques are more difficult and are probably more time-consuming. Gases or solids, while used, are not as readily applicable to Raman techniques. So far, determinations are intermittent. A drawback to plant operations is the high degree of clarity required in the solution, as scattered light must be reduced to a minimum for best results. Fig. 12 shows the basic optical system of the Raman spectrograph (Applied Research Laboratories).

MOLECULAR MASS

Essentially, this type of spectrometer ionizes a sample of a gas or vapor, sorts the ions according to their molecular weights and determines the relative number of ions of each mass.

How this is done is best shown in the diagram, Fig. 13. The gas or vapor to be ionized is admitted at low pressure to an ionization chamber, where the molecules take on electrostatic charges, some of the molecules incidentally being split into two or more pieces, also charged. The charged particles are accelerated by an electrostatic field into the curved tube,

as shown, where they are subjected to a magnetic field. Depending upon the mass of the particle, a different degree of magnetic force is required to bring particles of a given mass through the exit slit of the spectrometer and on to a collector plate. Current from this plate determines the concentration of the particles of the given mass present in the beam.

By continually varying the magnetic field and recording the intensity of the current obtained at the collector plate, a record is obtained which is known as a mass spectrum. From it the number of particles of different masses can be obtained, and by the use of computers the composition of the original material can be determined both qualitatively and quantitatively. The instrument has been used principally for hydrocarbons, but will give results on any substance which can give a vapor pressure of 1 micron, except substances which are strongly absorbed by glass.

These instruments are large and expensive and are not readily adapted to continuous monitoring of process streams. At least three instruments, however, have been developed for this purpose. The more complicated of these (Consolidated Engineering) is a modification of the standard instrument. It has a continuous sampling system and scans only the tops of selected spectral peaks to give desired information. It standardizes itself automatically, reducing maintenance to a minimum, and is pressurized to prevent fire and explosion.

Two other mass spectrometers are under development (General Electric) with radically different principles. One, known as the Bennet radio-frequency type, employs the principle that the acceleration of an ion of a given mass depends on the radio-frequency potential applied to its path. By a series of pulses of a fixed frequency and a given potential at the collection electrode, it is possible to collect only those ions which have obtained maximum acceleration at the collection electrode. By varying the frequency, the spectrum can be scanned. The whole is enclosed in a vacuum tube as shown in Fig. 14.

The second type of instrument is the ion-resonant type, or "O magnetron," as shown in Fig. 15. In this instrument crossed radio-frequency and magnetic fields cause the ions to spiral out, only those corresponding to the radio frequency used reaching the collection electrode. Here again by varying the frequency the spectrum can be scanned. These instruments offer interesting possibilities for monitoring process streams.

X-RAY ABSORPTION AND DIFFRACTION

X-rays can be applied in a number of ways to process control problems. Probably the most familiar is the standard X-ray photographic technique applied in medicine, which has been extended to the investigation of holes and encrustations in castings. A more advanced technique of analysis is the X-ray diffraction method in which fine powders are subjected to monochromatic X-radiation. The angles and intensities of the diffracted rays are characteristic of the compounds present in the powder, and hence the components present are determined. The intensities of the rays obtained can also give quantitative determinations from records either obtained photographically by Geiger counters.

A further X-ray technique which offers considerable promise in process control because of simplicity is X-ray absorption, similar in some ways to the technique used for castings. It is based upon the fact that the absorption of X-rays depends upon the mass of the atoms. As originally developed, it was possible to determine tetraethyl lead in gasoline due to the large difference in mass of the lead compared to the carbon and hydrogen of the gaso-

line. An accuracy of 1 part by weight of TEL in 14,000 parts of gasoline is obtained.

A recently developed X-ray photometer for this type of analysis (General Electric) can be made to operate automatically. Its principle is very similar to that of an optical null spectrometer. Two cells are used, and the X-radiation passed alternately through each cell and onto a fluorescent screen. The light on the screen is detected by a photoelectric cell, and the output suitably amplified. One cell contains the sample and the other the reference material. The X-ray intensity through the reference cell is varied to balance the absorption in the sample cell by means of a variable-thickness aluminum attenuator.

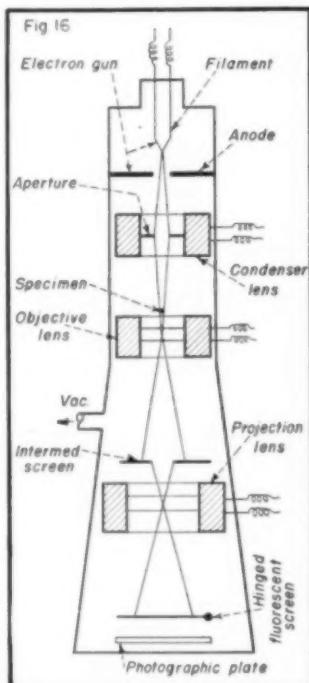
Applications claimed besides TEL in gasoline are sulphur in oil, heavy metals in glass, chlorine or fluorine in plastics, and the concentration of filler and impregnating agents in wood, cloth, etc. It is evident that this instrument has a wide range of potential applications. Its sensitivity varies from 0.01 to 1.0 percent, depending on the difference in mass absorption coefficients of the elements involved.

OTHER PHYSICAL PHENOMENA

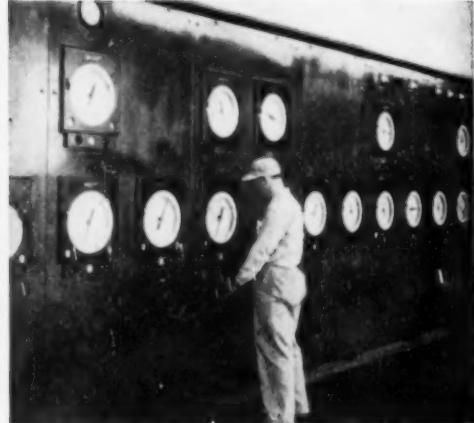
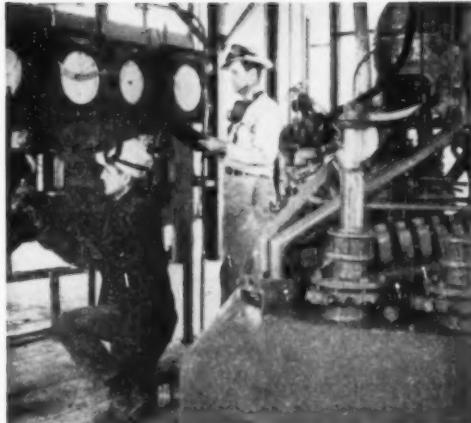
Electron diffraction is similar to X-ray diffraction and gives the same type of information, except that it is a beam of electrons which is being diffracted. Since electrons have little penetrating power, electron diffraction is restricted, but is very useful for the analysis of surfaces and surface coatings.

Electron microscopy is similar to ordinary visible microscopy except that the wavelength of the electron beam is much shorter than that of ordinary light. Thus much smaller particles can be seen and smaller features of an object can be distinguished. Electron microscopy uses magnetic lenses, and the image is formed on a fluorescent screen and recorded on a photographic plate. A schematic diagram of the optics is given in Fig. 16. The electron microscope is finding widespread use in controlling the size and shape of particles in carbon black and in pigments, or wherever particle size is a factor. Most electron microscopes are equipped to do electron diffraction work.

Absorption of microwaves utilizes radiation in the 1 to 100-cm. region. At the present time microwave spectrometers are not even in general laboratory use, although some experimental work indicates that this technique will be useful for identifying a considerable number of gases.



ELECTRON MICROSCOPE helps measure quality of carbon black and pigments.



SAFETY and reduced labor costs result when scattered control points (left) are centralized in one location (right).

Instrumentation Pays Its Own Way

Where plant investment is increased, instrumentation must produce sufficient dollar savings, or other less tangible benefits, such as safety or quality control.

F. H. TRAPNELL, J. JOHNSTON, JR. & W. A. CRAWFORD

The instrument engineer is a relative newcomer to the industrial scene. It has been only since 1946, when the Instrument Society of America was founded, that instrument engineering has become recognized nationally.

During this period industry has begun to realize that many savings can be accomplished through instrumentation. Instrumentation excels principally in reducing operating cost. However, examples of straight reductions of investment are not unusual.

INTANGIBLE BENEFITS

In addition to these two factors, there are several less tangible benefits

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A 1931 graduate of V. M. I., Mr. Trapnell is a 20-yr. man with Du Pont. His current assignment includes responsibility for atomic engineering instrumentation design. He is a regis-

attributable to instrumentation. Automatic control has gone far in improving consistency of product quality. Remote operation of hazardous processes provides the modern operator with a safer place to work. Remote control, automatic interlocks and signal systems protect against process abnormalities which could result in the loss of large investments.

Factors such as these cannot be evaluated in a savings calculation. Perhaps they should be considered as "insurance."

What types of savings does instrumentation provide?
Reduced Investment Only—Savings

tered professional engineer in Delaware.

Mr. Johnston, also a Delaware professional engineer, is responsible for instrument engineering assistance supplied to operating plants. Prior to employment by Du Pont, he was associated with oil refinery instrumentation and with Brown Instrument Co. He is a 1935 graduate of Drexel.

Mr. Crawford has been with Du Pont since graduation from Case Institute in 1939. His present duties include responsibility for all instrumentation design on commercial projects.

of this sort occur quite frequently when comparing a batch process with a continuous process. Investment in equipment for a batch process is generally higher than for a continuous process, although the latter may require more instrumentation.

The instrument engineer strives for minimum investment in his everyday work as he reviews estimates and quotations for different control systems. He often recommends changes in process equipment which will permit use of a preferred control system at a minimum over-all capital cost.

Reduced Investment with Reduced Operating Cost—This form of double savings occurs infrequently in instrumentation work. However, we have encountered one or two instances of this type in comparing batch with continuous operations as mentioned above.

Increased Investment with Reduced Operating Cost—Instrumentation does its biggest job in this field. Automatic control relieves the operator of burdensome routine work. Through more extensive use of automatic control the operator in a modern plant now performs a job which is mainly supervision.

Although usually requiring additional investment, further operating labor savings can be achieved by

proper arrangement of instrumentation so that supervision of one process step may be consolidated with other process steps. This permits one man to follow several operations. If the panelboards for two process steps are located next to each other, one operator's duties may be consolidated with that of another. The modern central control room is a result of this factor.

Reduced Investment with Increased Operating Cost—Instrumentation very seldom contributes to this form of saving. However, in many cases a savings calculation of this type may indicate the extent to which instrumentation can be justified.

Reduced Operating Cost Only—Instrumentation savings without increase in investment are mostly limited to reduction in maintenance labor.

EFFECT OF TAXES

Any discussion of savings calculations must consider the effect of taxes on the final answers. Today's Federal income taxes on profit are a very significant factor in any economic evaluation.

If we invest a dollar in instrumentation to reduce operating labor, how much of this dollar must be saved each year to bring a return of 25 percent, or even 10 percent, on the investment? If we assume a maintenance rate of 5 percent and a depreciation rate of 6 percent per year, the answer is about 65 cents to bring a return of 25 percent, and 33 cents to bring a return of 10 percent.

INSTRUMENT INVESTMENT RATIOS

A lot of information has been published concerning percentage of investment in instrumentation. Unfortunately, the data published have not provided a realistic concept of actual investment, since percentage basis has not been clearly established in all cases.

If we consider instrument investment percentage based on total plant cost, this cost, in some cases, includes real estate, office and service buildings, power facilities, etc., in addition to the production or process facilities. If, on the other hand, we consider only process facilities, the percentage figure will, of course, be entirely different. In other cases, instrument investment is established on the basis of only the actual process equipment, and does not even include cost of the building in which the equipment is installed.

In spite of these discrepancies, many people today speak of "normal investment ratios" without qualifying their figures. Company executives and chief engineers have been told that instru-

mment investment should normally approximate certain percentages. They think in terms of 2, 5, 10, or even higher, depending on the particular group supplying the information. It is true, of course, that actual percentages vary in the extreme, depending on the type of facility involved. However, a set of "ground rules" needs to be determined and publicized for use in reporting or recording instrument investment data.

Preparation of such procedure could well be accomplished by committees now established as a permanent part of the Instrument Society of America's working organization. This matter warrants some extensive study; it is neither advisable nor possible to go into such details in this article.

Regardless of these considerations, today's trend in instrumentation is toward an increase in investment percentage. Therefore, it is more important now than ever before to place installation of instrumentation on a sound economic basis.

INSTALLED COST FACTORS

The instrument engineer can always ascertain the purchase price of the equipment he is recommending, but this may amount to only half of the total installed cost. The other portion consists of field installation labor and material. This cost he estimates by studying previous installed cost figures. In addition he many times makes individual studies of portions of the installation to determine costs more accurately.

Why haven't factual data been developed to aid him in making these evaluations? One of the most obvious answers to this question is that instrumentation is a relatively new engineering field.

In reality it can be said that this field has never had a chance to settle down and obtain factual data. The continual introduction of new, more modern instrumentation has left behind it a wake of successively different designs. Each design has been introduced to improve operating performance and economy and reduce maintenance. However, with each change in design, construction methods have to be changed. Cost accounting methods have not kept pace with these changes, and the available cost figures, therefore, have often been difficult to interpret.

To top it all, during this same period of development the rise in the construction cost index has been so great that past cost records are confusing. It may be some time before conditions stabilize to the point where the instrument engineer can accumu-

late completely reliable data to use in economic evaluations.

NEW PROCESSES NOW PRACTICAL

Instrumentation has made possible some processes which were considered too dangerous or too impractical to operate without instrumentation. In these cases, instrumentation should be considered just as basic to the process as pumps, heat exchangers and other process equipment. Any justification of instrumentation must be included in a justification of the entire process itself. Here care must be exercised to avoid unnecessary costly elements in the system.

Some examples of this are worthy of mention. Remote control is a "must" in the design of processes for atomic energy. These processes have proved that instrumentation could be relied on.

Many communities have converted from manufactured gas to propane-air mixing stations made possible through appropriate instrumentation. This change has greatly reduced operating costs and maintenance, and in several instances the entire investment has been written off in one year. Mixing stations are unattended, and savings realized through reduction of unaccounted-for losses have been significant.

In the rubber industry, mass production methods are applied to chemical processing by means of time-cycle control. Here is an industry whose continuing success is based on specially engineered instrumentation. In fact, the problem of rubber autoclave control implemented the development of cascade control systems.

The steel manufacturer has reaped a tremendous benefit in the form of precise temperature measurement of moving sheet. The use of low-temperature radiation pyrometry has extended these benefits to film processing and to work carried on in rotating machinery.

COST REDUCTION ON NEW PLANTS

In spite of a skittish cost picture there are many interesting examples of savings produced by instrumentation on new plants. In one particular case, instrument engineers recommended fully automatic scanning equipment which would continually monitor some 500 temperature readings, provide an audible alarm and record actual readings when desired. The total cost of such equipment was in the neighborhood of \$50,000. The operating group concerned had obtained such readings in the past by manual means and were not at all convinced that this investment was justifiable.

To establish such justification, design engineers were required to provide cost estimates for six different schemes. These involved every possible arrangement, from merely installing temperature test wells and providing operators with laboratory thermometers, through various combinations of indicating equipment, to the fully automatic monitoring system. The actual decision in this case was influenced by a good sales job on the part of an instrument engineer, and the automatic system was installed.

At start-up this system permitted establishing equilibrium in the process in record time. Based on past experience in balancing out such processes, plant operating supervision estimated that this equipment paid for itself during the first 72 hr. of operation. This, of course, is an unusual case, but there are no doubt many instances where such savings could be realized if sufficient time were spent in actually studying past practices and comparing them with the achievements possible through instrumentation.

OPERATIONS AT LONG RANGE

Gas utilities in thickly populated communities in northern New Jersey, receiving natural gas from Texas, can now control from a central location the distribution of gas to their numerous zones. This is accomplished by long-range telemetering systems and remote control apparatus which permit gas pressure control for particular customer needs within very close tolerances. Load changes can be balanced conveniently and still satisfy the demands of preferential customers. In case of emergency, specific sections can be isolated and the location or magnitude of leakage determined.

There have been many cases where return on investment has appeared extremely dubious during initial operation. However, we feel certain that in the vast majority of such instances, the pay-off has eventually been realized.

In one particular instance an initial investment of approximately \$90,000 provided continuous ultraviolet and infrared gas analyzers to eliminate labor and delays for laboratory analytical work. The principal justification was the possibility of improving plant operation by the continuous and immediate knowledge of the composition of materials in the process. Unfortunately, the original analytical instruments as designed did not withstand the inroads of unexpected atmospheric contamination.

After a large amount of maintenance had been expended to keep them in service, the instruments were

rebuilt and properly housed in a separate specially ventilated building. It was necessary to spend an additional \$100,000 for this installation. The additional expenditure was justified mainly on the basis of protecting the facilities.

During the period when the analyzers were out of service, the actual man-hours involved and the subsequent delays experienced by using laboratory analytical methods were very much in evidence. It is estimated that the entire cost of this instrument installation was \$250,000. However, some three years after the initial installation, equipment and instruments are operating satisfactorily, laboratory methods have essentially been eliminated, and operating management feels that the investment has been a wise one.

REAPING UNEXPECTED BENEFITS

Sometimes returns from instrumentation are unexpected. In one case, the ability to operate on a semi-continuous basis was realized through sequence time cycle. The flow of raw material alternately passes through regenerative catalytic converters. Prevention of any possible mixing between regenerating gases and flammable vapors is accomplished through an elaborate system of pneumatic interlocks.

This was one of those intangible cases where instrumentation was justified almost entirely on the basis of operating safety. However, actual operating experience on automatic control permitted the cycle to be decreased to one-sixth of its original time, with a longer maintenance-free period.

One of the large dividends realized through centralized instrumentation is the freedom to erect chemical plants out of doors. Elimination of buildings to house equipment has produced substantial savings in the chemical and petroleum industries. This cannot be done unless operation of the process is concentrated in a properly designed control room through the medium of remote transmission and control implements. In addition to reduced investment, there are intangible savings in operating costs and safety through the rapid dispersion of toxic or explosive vapors in open-air construction.

MODERNIZING OLD FACILITIES

Instrumentation plays an important role in modernizing old facilities. All the benefits gained on new plants can be obtained on old ones, and additional returns can be realized in space savings, better yields, etc. However,

direct savings through instrumentation are often more pronounced when considered as part of a study to increase capacity of the facility.

A good example is one having to do with the design of a solvent recovery system. In this process the capacity of certain towers was limited by the proportion of flammable vapor in air which was maintained in the gas stream entering the towers. This proportion was kept considerably below the lower explosive limit of the mixture. Increased plant capacity could be obtained either by adding new towers or by operating closer to the lower explosive limit.

An installation costing approximately \$80,000 was made. It utilizes a number of infrared analyzers which sample the gas stream at a number of points and record for the operator the instantaneous composition. Capacity of the towers has been increased by operating closer to the lower explosive limit; no additional process equipment was required.

Pasteurization is accomplished 100 times faster by means of recently developed milk processing control instruments. Performance and records of dairy instrumentation are accepted legally as meeting strict health requirements.

Because instrumentation is so closely affiliated with operating labor there have been several cases where instrumentation has played an important part in capacity increases. In one instance the plant capacity had been increased several times previously without needing additional operating labor. This latest increase was going to require additional operators.

In the original installations, the instruments had been located at the operating equipment; subsequent additions of the same sort would mean still further decentralization. A complete operating study of the plant with the proposed additional capacity indicated that it was more economical to replace all of the original instrumentation with centralized control and modern equipment. The plant could then be operated without additional labor and still achieve the desired capacity increase.

CLOSER CONTROL UPS YIELD

An example of higher product quality attained through instrumentation occurred in a recently revamped solvent refining system. The final distillation column was placed under automatic control to produce an overhead of refined solvent and discharge small amounts (about 1 to 2 percent) in the high-boiling impurities leaving the bottom. Under previous semi-automatic operations the

bottoms contained more than 50 percent of product in the high-boiling impurities, necessitating batch reworking of the bottoms in additional equipment.

In the field of combustion control there are many examples of as high as 12 percent fuel and other operating savings through automatic control. Reduced investment in terms of smaller water space in modern boilers is feasible only because of comprehensive 3-element feed-water regulation in combination with fuel:air ratio and furnace draft control.

By the use of instrumentation in the food industry for cooking and sterilizing, uniformly high quality processed foods are guaranteed. Through precise control, spoilage is virtually eliminated in the canning and freezing industry.

EFFECT OF MAINTENANCE COST

As the trend toward increased investment in instrumentation continues, the part which maintenance cost plays becomes more and more important. Yearly instrument maintenance costs may vary from $\frac{1}{2}$ to 9 percent of the instrument investment.

Percentage figures of this sort are inclined to be quite misleading. Some of the factors which influence the cost of construction equally influence the cost of maintenance. Some plants have installations of as many as three or four basically different types of instruments. It is almost impossible to pin-point particular maintenance problems to certain types of equipment with the present cost accounting methods used. To top this all off, a great deal of trouble-shooting and development engineering is commonly called maintenance work and thrown into maintenance cost records.

RELIABILITY IS IMPORTANT

Maintenance costs are not always the most important consideration. In modern continuous processes the failure of an instrument may cause serious delays. The reliability of the instrument is by far more important than the cost to maintain it. Consideration of reliability also influences investment costs. It is good economy to pay more for equipment which is known to be reliable if this additional investment will insure continuity of operation.

In the choice of equipment for new plants, the design engineer is plagued with a very definite problem—the economics of investments vs. maintenance. Standardization of types of equipment reduces maintenance costs in several ways. In the first place, investment in spare parts is minimized.



MAINTENANCE is an important consideration in instrument economics.

Secondly, minimizing the types of equipment provided for the plant minimizes the job of training instrument mechanics.

Today's instruments are engineered with maintenance in mind. Although the entire control system looks complex, the trend is more and more toward the use of combinations of plug-in components which are readily removed for alteration or repair. The extensive use of large numbers of similar devices simplifies maintenance but may add to the initial investment.

Maintenance costs will rise in proportion to the use of instruments and in proportion to the dependence placed in them for process operations. If additional attention is required to guarantee precision results, a further increase in maintenance cost can be expected.

Maintenance considerations have, in some cases, reaped additional rewards. At one particular plant troublesome tank scales were replaced with recently perfected pneumatic force-balance systems for weighing. These have been in service for the past three years, operating continuously with satisfactory accuracy and, most important, absolutely no maintenance has been required. In making this change the investment was also reduced.

AIR SUPPLY IMPROVEMENTS

For years instrument air supply was an important maintenance problem. Much of the success of modern instrumentation can be attributed to the adequacy of modern engineered air supply systems. The effect of this is seen in a recent installation where all of the controllers supplied were of

the stack type—particularly sensitive to unclean air. This installation was made three years ago and, to date, not a single one of the controllers has been dismantled for cleaning or repair.

Maintenance is closely associated with development engineering. A process placed in operation four years ago was designed without the benefit of pilot plant or semi-works information. Considerable difficulty was experienced with the operation of the commercial plant.

Only in the past year, since elimination of instrument problems, has successful operation been attained. There is absolutely no question but that this particular process would be impossible to operate without the benefit of adequate instrumentation. Many of the problems encountered here required repeated trials of ingenious combinations before successful solutions were obtained. Although the instrumentation cost on this plant is virtually triple what it would have been with the benefit of pilot plant experience, the plant is today operating at better than design capacity and a great deal has been learned about accomplishing the seemingly impossible.

Maintenance cost comparisons are difficult because of the variety of accounting interpretations encountered. One of our plants sought to reduce operating costs by discharging their one and only instrument mechanic in favor of occasional use of instrument manufacturers' services. They operated for a period of two years with a very favorable reduction in maintenance costs, by the books.

Quite recently it became apparent that re-employment of an instrument mechanic would be desirable. A survey indicated that approximately two man-years would be required to reinstate the former level of instrument performance. Lack of attention had fostered an accumulation of malfunctioning apparatus. Operators began to rely on manual methods and a gradual increase in operating manpower occurred. As the number of instruments falling into disuse increased, the duties of plant supervisors were also increased. For example, steam distribution facilities became more and more of a rough estimate until all semblance of factual cost data disappeared.

INSTRUMENT TROUBLE-SHOOTING

The maintenance engineer is in a good position to see many cases where the desired return on instrument investment is not being realized. These are cases where instruments have fallen into disuse because of one of these common faults:

Method of installation caused unpredictable results.

Selection was based on misinformation.

Selection did not satisfy changed operating conditions.

The particular installation was poorly engineered in terms of materials of construction; incompatible with the actual operating conditions; complexities beyond the user's comprehension; incorrect range or size.

Operational improvements have eliminated measurement or control needs.

Training of operators or maintenance personnel was inadequate.

Maintenance has been incompetent. This can result directly in failure for any of the previously mentioned reasons, because unsympathetic maintenance can produce lack of appreciation for installation requirements, operating limitations, and inability to modify inherent characteristics to suit changed conditions.

REVIEW AND FORECAST

Instrumentation has in the past few years gained a strong foothold in various fields of manufacturing. We can

expect the plants of the future to have greater investments in instrumentation than those of the present. At the present, in new plants, instrumentation is saving money in the following tangible ways:

Decrease in investment.

Decrease in investment with decrease in operating cost.

Increase in investment with decrease in operating cost.

In addition to these, many intangible savings are obtained through instrumentation. These will continue to be important in the future:

Greater safety of operation, better working conditions, and greater safety for operators.

Higher product quality.

Make possible processes which were heretofore impossible.

In addition to savings made in new plants, instrumentation can provide savings in modernizing old facilities. These generally occur when an increase in plant capacity is being considered, but in many cases can stand on their own merits.

The transition from batch to continuous processing has brought with it the invention of appropriate instru-

mentation. Ample demonstration of the advantages of modern instrument use has been experienced, and those installations in which it is justified are readily recognized.

Some idea of a typical reduction in operating costs is indicated by the fact that in one modern plant the investment per operating employee amounts to over \$50,000, compared with \$18,000 in the case of an older unit. The new plant also operates more efficiently and yields higher quality under safer working conditions.

WANTED: MORE DATA

The phenomenal growth of instrument engineering has taken place during a hectic period involving both a world conflict and unheard of economic upheaval due to inflationary tendencies and increased taxation. In most fields of engineering it is possible to report on the economics of its various phases by citing specific data available as a result of many years' experience. Firm and factual figures in the field of instrument engineering have been difficult to establish, but the time has come when factual data must be compiled.

A Critical Look at Graphic Panels

Instrument engineers are enthusiastic supporters of graphic panels, but operating management wants to know whether they're worth the extra cost.

WESLEY T. DORSHEIMER

The graphic instrument panel is today an important and highly controversial subject of discussion for engineers in the process industries.

It is difficult to determine just when the graphic panel idea was first conceived, but it was not used extensively in process work until after World War II. There were a few elementary graphic installations as far back as ten years ago; these were in the electric power and oil refining fields. The idea was just getting started when the war came along and halted its normal

growth. Industrial production moved into high gear for the war effort; and, of course, manufacturers were in no position to develop the new lines of instruments required for graphic panels. Since the lifting of restrictions after World War II, however, they have made rapid progress.

A great deal has been written about the use of such panels in the petroleum industry. A survey completed in April 1950 disclosed that as of that date, 14 oil companies had already installed graphic panels, and 10 more

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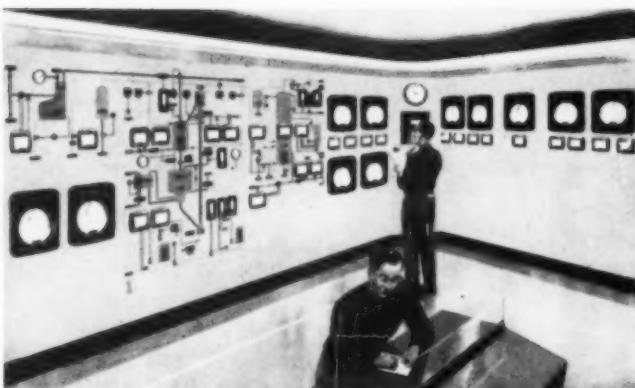
In the preparation of this article Mr. Dorsheimer made an informal survey of 50 engineers in the chemical proc-

ess industries. Although instrument engineers were thoroughly familiar with graphic panels, operating, design and process engineers wanted to know what they were, how they work, their background and development, and their advantages and disadvantages. This article answers these questions.

reported that such panels were under investigation. That was two years ago, and, since then, graphic panels have made great gains in popularity. Today, it has been conservatively estimated that there are more than sixty such installations in oil refineries and petrochemical plants throughout the world.

There has been much less published information pertaining to the use of graphic panels in other process industries, and we may ask whether they are being used to any large extent in other fields. It is probably true that there are more graphic installations in the petroleum industry today than in all other process industries combined; but the potential in these other fields is large.

Almost every company using centralized instruments for process control is involved with graphic panels to some extent. Some have had them



COMBINATION panel has full graphic, modified and console sections.

installed and operating for some time. However, because of the confidential nature of the flow diagrams used on such panels, little publicity has been given to installations in chemical plants. Others have graphic panels on order now; still others are definitely planning to install one on trial at a future date; and most of the remainder are seriously discussing the pros and cons. A continuous process, such as petroleum refining, lends itself ideally to the utilization of graphics, but such panels are also proving of value in semi-continuous, cyclic and batch operations.

In the chemical industry, the Du Pont company was one of the first to install a graphic control board.* In 1947, Du Pont was confronted with a situation often encountered in industry, where the operating personnel for a particular unit were to be hired on the site, and would not be familiar with the process. It was decided to bring the process to the operator; this was the origin of a number of graphic installations by Du Pont.

Almost without exception the 20 largest chemical companies are either designing, or already operating, plants with graphic panels. In the pulp and paper industry there are probably a dozen mills under construction which will use graphic panels in one or more departments. The electric power industry was among the very first to utilize the principles of graphic panels. Information concerning installations in the atomic energy field is, of course, confidential; but it is estimated that there are more than fifteen graphic panels under construction or already installed in this field at the present time.

WHAT IS A GRAPHIC PANEL?

A graphic panel presents a simplified replica, or flow diagram, of the process, and instrument components are placed in this diagram in approximately the same relative positions as are their points of application in the actual process. These components can be indicators, recorders, controllers, signal lights, push buttons,

pump starters, switches, remote valve operators, etc.

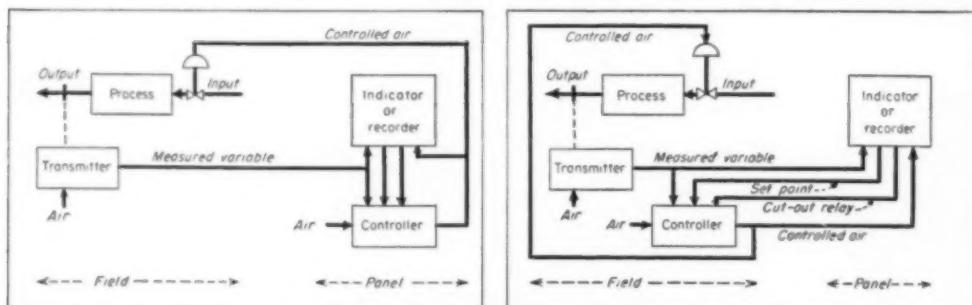
The graphic panel has led to the development of a line of small instruments for this purpose. It should be emphasized here that, although these are often termed "miniature" instruments, this refers only to the fact that they take up less actual panel space. The functions of the large round-chart instruments have, on the whole, been retained in these smaller instruments. A record or indication of measured variable, a setting index, some method of determining controller output pressure, and some method of transferring from automatic to manual operation and vice versa, are usually provided.

Miniaturization of panel instruments has been the logical outgrowth of a prior, more fundamental development in instrumentation—centralized control. As larger plants went in for more and more centralization of control, transmission lags between process and panel became exorbitant. The solution to this problem was to separate the controller from the indicating or recording instrument, mount the controller at the process, and transmit measurements from the process to the panel and set-point adjustments from the panel to the controller in the field.

Removal of the controller from the instrument case made it possible to compress the indicating or recording mechanism into the smaller frontal area desired for graphic panel work.

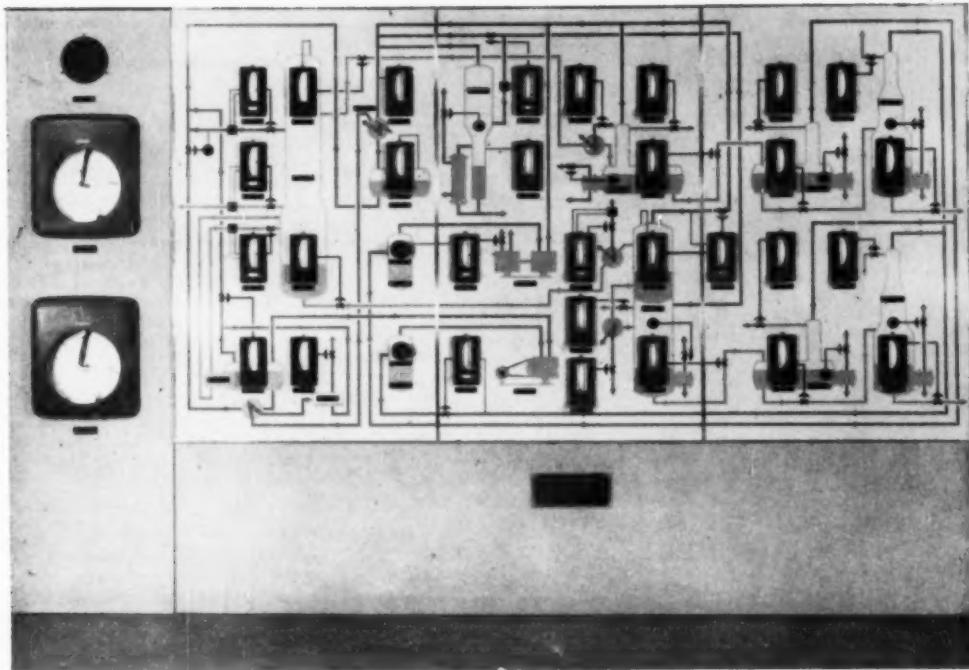
Better control of continuous processes has also permitted using narrower ranges on recorders. This means that the compact recorders used with graphic panels can record data just as accurately as conventional ones.

Location of the controller, whether at the process or at the panel, determines whether two or four connections between field and panel are used (see diagram below). Field mounting



PANEL-MOUNTED controller needs only two connections with the field, but introduces transmission lags.

FIELD-MOUNTED controller reduces transmission lags, requires four connections with the panel.



FULL GRAPHIC panel, in this case, uses indicators only. Permanent records are provided by conventional recorders.

eliminates transmission lag, but requires a more complicated system of connections.

FULL, MODIFIED AND CONSOLE

Graphic panels have taken many different forms.* The full graphic contains a fairly complete process picture on the control board. The modified form shows only a few of the most important pieces of process equipment; most important, that is, from an operating point of view. Various other arrangements of operating panels using the new, smaller instruments have been grouped under the name of console panels. These panels often include a desk for the operator and usually group the instruments so that most of the critical controllers are within reach of the operator from a single position. In this type, recorders and controllers are placed either in rows, as on the conventional panel, or in other forms of groupings, but the flow diagram is not used.

Many combinations of the graphic and console have been used. In many cases the form is dictated by the particular line of instruments available from the manufacturer selected.

The manner of laying out the panel depends on individual preference;

the straight type, wing-back, and U-shaped arrangement all have their advocates. In the earlier graphic boards, the process equipment models were often shown in relative size; i.e., fractionating columns and furnaces much larger than tanks and receivers, and these, in turn, larger than exchangers and pumps. However, the trend now is to show the process equipment no larger than is actually required to surround the necessary instruments.

At the present time a number of different methods are being used in fabricating these panels. In one common method, anodized aluminum sheets of different colors are cut in the form of the different pieces of process equipment; aluminum strips are used for the flow lines. These are all fastened to the steel panel. Until now, these aluminum pieces have usually been attached with screws, but an adhesive method has recently been developed which may prove advantageous. If the diagram must be altered, the pieces can be removed by dissolving the adhesive, and the panel remains unscarred.

Another method consists of fabricating the panel from Formica sheet of a neutral background shade, into which are inlaid the various lines and

equipment symbols in different colors. This inlaid section is covered over with a transparent sheet, and the several layers are then bonded together under high temperature and pressure. The result is a smooth, easy-to-clean, attractive surface, with the diagram portrayed in distinctive colors. Although this presents a better over-all appearance, it is much more costly.

In a third method, the process picture is painted directly on the steel panel. Other methods, such as the silk-screen method of transferring a photograph to the panel, have not been used to any great extent.

PROS AND CONS

Operator Training — It is much easier to train new operators with the graphic panel. With the tremendous expansion taking place in industry today, most companies are placing their more experienced operators in supervisory positions, and a large percentage of the operating personnel in each new plant, or plant expansion, are inexperienced. While the plant or unit is being constructed, the operators can receive simultaneous instruction on the blueprint flowsheet and on the graphic panel. To aid this simultaneous study, both flow sheet and

panel should follow the same general arrangement as to location of equipment.

Normal and Emergency Operations —The graphic panel aids in making smoother start-ups, and, once on stream, it is easier for the operator to correct an unusual process upset before it reaches sizeable proportions. This is of importance today and will be of even greater importance in the future. With each passing year, the process industries use more and more automatic controls, and their supervision becomes more complex under start up and under emergency conditions. In general, after three to six months' operation of a new unit, the average operator, whether the panel be conventional or graphic, is thoroughly familiar with the panel locations of all instruments. He is also sufficiently familiar with their function, and how they fit into the process, to be able to make all the routine adjustments of controller set-points, etc., that are required for normal performance.

With conventional panels, it has often been found that, although the operator can cope with the average daily conditions very satisfactorily, he is not sufficiently well acquainted with the relation of the instruments to the process to be able to handle emergency upsets quickly. For example, it would not be unusual for an operator to think that the valve positioned by a particular temperature controller is located in the process line at the outlet of a heater, whereas the valve may actually be in the steam line to the heater. Under normal operating conditions, it may do no harm for the operator to labor under this misunderstanding. However, should an emergency arise, it may be vitally important for him to know precisely where this valve is located. Here is where the graphic panel, with its process picture clearly outlined, proves of great value.

Appearance — There is a certain amount of eye-appeal to these graphic panels. In some cases this is considered of advertising value; for example, some oil refineries install them in large "picture windows" where the public may view them. Also, they are almost always installed in modern, well lighted, well constructed control rooms. The whole room, with its attractive panel display, proves to be a stimulating influence on the operator and creates a certain pride in him towards his job and place of work.

Education — When supervisory personnel, engineers from the head office, students, customers, or others not completely familiar with the locations of all the instruments visit the con-

trol room, they can, by means of the graphic display, more readily understand how each instrument fits into the process.

Communication — In plants where rotation of operating personnel is practiced, it has been found that operators require a minimum amount of review time when returning to operate a graphic installation, and they more readily regain a sense of confidence.

Safety — The graphic panel simplifies and clarifies the process, and for that reason is advantageous from a safety viewpoint.

Space Requirements — The relative size of a graphic panel in comparison with a conventional panel depends upon the process and instrument density. In the average case the panels are about the same size. In complex processes which have relatively few instruments, graphic panels have proved to be larger than conventional panels. In simple processes with heavy instrumentation, graphics have some space-saving value.

Cost — In a comparison on the basis of cost, for most processes the full graphic is appreciably more expensive than the conventional control panel. The modified graphic is only a little higher in cost than the conventional; the console panel is less expensive. These estimates represent the average of a large number of installations. They cover only the cost of the panel, not the room in which it is housed, nor the instruments. The difference between the cost of the smaller instruments and the conventional larger ones is minor.

Theoretically, the shorter panel means a less expensive control room, but this does not necessarily work out in actual practice. Actually, installations differ so widely that it is not safe to generalize; the economics of each job should be worked out both ways before drawing conclusions.

Flexibility — In some plants it is necessary to alter the process continually, and this means frequent revisions to the panel flow diagram. This eventuality can occasionally be provided for when the panel is first laid out. Sometimes, however, it is difficult or expensive to rearrange the panel, and for these plants either conventional or console panels appear more suitable than graphic.

DESIGN OF COMPONENTS

Instruments that have been designed for use on graphic panels have engineering advantages outside of the graphic panel installations. They have been designed primarily on a component basis so as to yield maximum flexibility of installation. Since most of

the systems are engineered for pneumatic transmission, recorders, controllers and auxiliary equipment are equally applicable to flow, temperature, pressure and other process variables, and may readily be interchanged when process changes occur.

Controllers have been designed to be mounted directly on recorders without additional piping or mounting, or to be mounted on separate manifold on the panel, or on separate manifold at the valve. The location is dependent upon the manufacturer of the equipment and the process conditions. Also available for teeing into the pneumatic lines are various indicators, electric and pneumatically operated alarms, and uniform and square-root scale flow integrators.

The component scheme has also been carried into sub-assemblies. For instance, in one model the derivative function can be added to a controller by merely substituting a "derivative" plate for a "blank" plate.

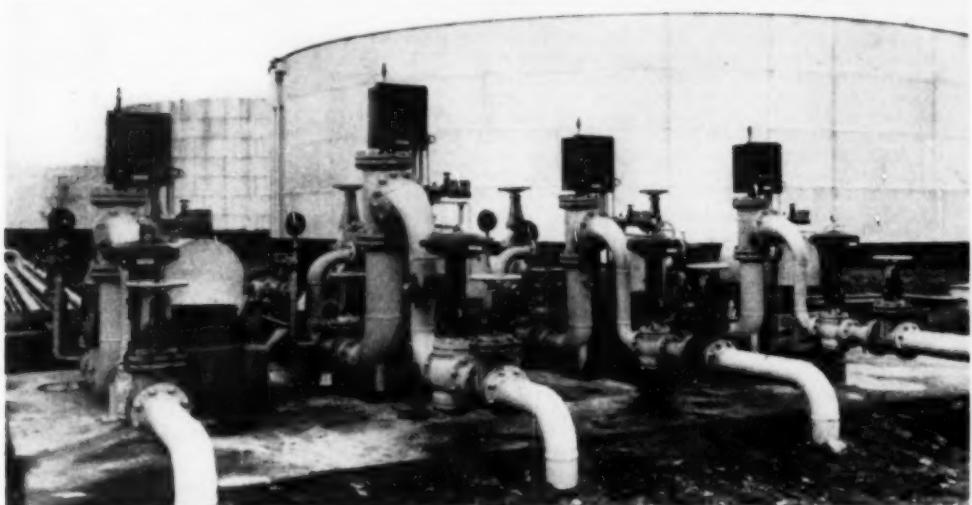
WHAT OF THE FUTURE?

Predictions for the future are legion. Some enthusiastic proponents of the graphic school believe that almost all central control panels will eventually follow this form. Others, after using graphic panels on a few processes, do not feel that the advantages gained are worth the additional monetary cost and loss of flexibility. A few have gone so far as to state that they will never again use a graphic. Some engineers feel that industrial instrumentation of the future will be all-electric, and that central panels will be designed for utilization of scanners and central computers. Others believe that the trend will be in the direction of instrument panel layouts which use "line-of-sight" arrangements, where the operator can quickly glance at a long row of instruments and immediately determine whether any adjustments are required.

The value of the graphic panel undoubtedly varies widely, depending upon both the process to which it is applied and the skill with which the display is designed. Both graphic and conventional panels will find many applications. Although the newer line of small instruments will be used more extensively, the demand for the larger, conventional instruments will continue unabated.

REFERENCES

1. Grace, E. L., Jr., *Instruments*, Apr. 1951, p. 405.
2. Hurley, R. L., Jr., *Instruments*, Dec. 1951, pp. 1425-1429.
3. Tivly, V. V., *Petr. Ref.*, Mar. 1950, pp. 162-166.
4. Uhl, W. C., *Petr. Proc.*, Apr. 1950, pp. 361-368.



Control units directly at the process are often a consequence of the study of controllability during process development stages. Here large variable-area meters provide flow-ratio control of oil blending.

Instruments: Equipment, not Accessories

Instruments are part of the process loop as truly as a still or a heat exchanger. Not only must they fit the process equipment, but the equipment must fit the instruments for best results.

EDMUND D. HAIGLER

During World War II there was intensive development of military servomechanisms that resulted in units of extraordinary power, precision and

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speed—of course, at high cost. Since these servomechanisms are closely related to industrial process controllers, some users have been expecting similar striking developments in process control instrumentation.

However, industrial processes often involve complex lags and non-linear responses to which the conventional servomechanism mathematics does not apply. Still, there is a very important parallel: the mathematics, design and performance of servomechanisms are always tied into the application. In the sorts of use for which servos are applied, they are considered as parts of the process. They are not abstractions. The "feedback" through the process is considered an integral and necessary part of the "control loop," and it is recognized that the identical control units used in another process may perform quite differently because of the changes in the process portion of the control loop.

The same situation holds in process control. Instrument engineers have

long been insisting that control equipment is a part of the process—that it be built into the process—that such equipment is not accessory, to be attached to the process. This must be true when control is needed in the process, for the control operates from measurements derived from the process—as a consequence of corrections applied to the process. Furthermore, it should be true because the optimum process, layout, equipment and operation of an automatically controlled process may all differ from those preferred in manual control. This is a necessary conclusion from the differing capabilities of men and of instruments. Although instruments are continuously attentive and can remember and calculate proportions, derivatives, integrals and other functions, they cannot foresee or reason. Furthermore, although the graduated valve action in some types of control is similar to manual control, off-on control differs utterly from manual.

It is an unfortunate paradox that

many instrument application engineers must spend most of their time avoiding or correcting the consequences of control not being considered as part of the process. Perhaps this is to be expected since most of the literature on application of instruments stresses evaluation of process lags and selection of appropriate forms of control. The prior problems that determine whether the process is even capable of control, and what variables to measure and control, need more attention. That is a reason for this paper.

Naturally, in revamping old operations, instrumentation must be an after-thought, yet such are the capabilities of modern instruments that frequently important improvement in production or quality, or both—and consequent substantial extension of the economic life of an old unit or process—is possible through modern control. When deliveries of process equipment are slow and many mate-

rials scarce, reinstrumentation becomes especially important. Even in new installations, equipment designed particularly for automatic control may not be available at all, or not at an economic price. Moreover, such factors as urgent need of production, rapid change in markets, taxation, and shortage of capital, may emphasize further the attachment of refined instrument equipment to mediocre plant. Thus there are often sound economic grounds for violating the best control practice. Still, best operation is secured only when measurement and control equipment is thoroughly integrated with the process. This means taking control into consideration at every stage—from process development through plant layout, equipment selection, and installation, to operation and maintenance. We may forego the advantages of such planning as a considered choice, but they should not be lost through ignorance.

Controllability—From First to Last

Bringing controllability into the process development picture means taking a good look at control problems right in the beginning, when it pays the biggest dividends. Can the new process be operated safely and stably and produce the required quality at a competitive price? Are there safety margins in quality and cost for market changes? Even with an established process, study at this stage is desirable because seemingly minor changes can have marked control significance. For example, a distillation column designed for two-component feed failed to work when a bit of third component was present. Also, restudy is needed at intervals because new measurements may make changes desirable. Conversion from batch to continuous operation always brings new flow, flow-ratio and liquid level problems for either manual or automatic operation. Interconnected operations may multiply process lags and difficulties to a point where separation with surge tanks and averaging level control is required. On the other hand, interconnected control may subdivide the process lags and so solve such problems.

Of course, in radically new processes, initial consideration of controllability may be peculiarly vital. If control obstacles are not found at this stage, a lot of time and capital may be expended before the difficulties later become obvious, when correction certainly is difficult and expensive, if feasible at all.

Early study of controllability can steer away from hazardous and uncontrollable arrangements. It can steer

toward versions which are readily controllable. In fact, there are indications that many developments are abandoned without control studies which might have saved them. Here controllability was not even recognized as a factor in development.

When pilot plant design and operation are part of process development, it is particularly important to stress control problems. A pilot plant should not be sketchily instrumented at lowest cost. If the data are to mean much, more instruments will be needed than for a full-scale plant unit. First, the proposed control system should be complete. Why skimp when the instruments can be transferred later to the process-scale operation? Next, scale correction instruments may be needed. In a pilot distillation column, for example, surface-volume ratio may be so far from that of a full-scale unit that results will be doubtful or even useless without controlled-temperature jacketing to duplicate full-scale condensation and run-down effects—equivalent to increased reflux. Finally, additional records are needed to provide development and test data.

Uncommon are the pilot plants that have enough such instruments. Rare indeed are the jobs where the cost of these instruments is not recovered in a short time. Instrumentation for labor saving in the pilot plant pays off even more handsomely than in full-scale plants. Pilot operation is extra expensive in technical help and supervision, perhaps in costly new raw materials, too.

Considering controllability in plant

layout means more than simply instrumenting for convenient and economical operation. If centralized control is necessary to make operation efficient—or perhaps even possible—full consideration of instrumentation is needed also at this stage. More recorders will doubtless be advisable. The cost of remote manual valve operators and remote signals probably will result in more automatic control. Yet, cost or congestion may prevent complete centralization of instruments. What is practical—as well as possible in remote measurement and control—needs to be studied here; and with it process needs to avoid undue complication, delays in construction, start-up and operating difficulties or revisions.

Controllability is an important problem again in equipment selection. If the process is inherently stable and practically self-regulating, and the tolerances wide, there are few problems. But if instability is inherent and inevitable, or quality or cost margins narrow, selection of individual units of equipment for controllability may be critical. Then even a change of scale of equipment is significant, and constructional variations even more important. For example, a co-current or mixed-current heat exchanger may be uncontrollable unless exactly sized, yet a counter-current type is easy to control at any load. (Haigler, *Trans. ASME*, 60, 633-40, Nov. 1938). Unfortunately, many other items of equipment now offer little or no choice in regard to design for controllability. It is hoped that this situation may change.

Sizing of meters, valves and piping must be correlated to equipment. Compounding of factors of safety (or ignorance) must be watched, and due allowance made for the often substantial increase in equipment capacity that comes with automatic control. Also valve characteristics must be selected, for the control valve lift-flow characteristic usually has an important effect on controllability, and no single characteristic suits all measurements and processes. Energy and fluid storage must be analyzed as favorable or unfavorable and appropriate action taken.

That installation should be made with controllability in mind is obvious in principle but almost endless in detail. Installation instructions must be carefully and thoughtfully followed so that good measurements can result. Is each measurement made where conditions are most representative and responsive? Particularly with sampling instruments—such as those for analysis, gravity, humidity, pH, viscosity—is the sample lag low? Perhaps the sample point should be

changed or the measurement made in a process vessel to minimize this lag. Is process, instrument and purge piping suitably sized, pitched, vented, trapped or filtered? Do fluid meters have the right inlet conditions and are pulsation conditions within reason for the type of meter used? Are thermal elements selected in type and form to minimize transfer lag to the actual measuring part at the working temperature level? Are they then located to minimize transportation lag? Conventional wire thermocouples in a socket usually are too sluggish at low temperatures, although good at higher temperatures where heat transfer to the element is speeded by radiation. Higher temperatures aid, too, in that the process response is retarded by greater capacity lag (thermal storage). Does the control valve piping or capacity of the relay provide valve travel faster than the process response? Where instruments are outdoors or otherwise subjected to extreme temperatures, are they of suitable type or suitably housed? Where corrosion exposure is severe, are the instruments protected by air purge and wired to prevent bad connections?

Need to consider controllability in operation frequently is overlooked. Just because the setting pointer of a controller can be moved to a certain value does not mean that that condition can or should be reached. The control valve may be intentionally too small, or the fluid supply insufficient, or the equipment capacity inadequate. Again, the setting may be in conflict

with another controller or a safety device, or with fundamental chemical equilibria. Yet many service calls result from just such complaints. Non-linear scales also bring problems. The square-root flow scale of many head meters, and the vapor-pressure scale of many thermometers, means necessarily different control behavior at opposite ends of the scale. Even more extreme are the differences with the logarithmic pH scale. Two pH units, or one-hundredfold in hydrogen-ion concentration, is far beyond the rangeability of most control valves, yet complaints about a pH controller not following a setting change of several pH are encountered.

Finally, there is controllability in maintenance which also is of real importance. Routine and preventive maintenance of equipment and of instruments is well established in many plants, but sometimes more attention should be paid to the control significance of changes. What do algae, coke, dirt, scale or polymer build-up on heat exchange surfaces mean in overall results? When and how will increase in instrument friction from dirt or corrosion show up? What about valve erosion, tight packing, stem etching, or lack of valve lubrication? What about pulsation, vibration, or water hammer, and water or oil in the air supply? If the instruments once worked well and now do not, a change in operation or an omission in maintenance is likely. Much of the best instrument maintenance is done with the feet on the desk, con-

templating the ceiling—not by busily taking things apart.

Evaluation of controllability may be by analogy, or by analysis. Analogy is quicker, but great care is needed to avoid overlooking significant differences, particularly factors ordinarily omitted as unimportant. Process, product, or raw materials changes may be significant; likewise new types or sizes of equipment. Outdoor installations subject to several-fold changes in ambient swings, and to sudden chilling from showers (evaporative cooling), may behave differently. Even substitutions of materials in pumps and heat exchangers, or change to hard or unchlorinated cooling water, may result in rapid change in performance from corrosion, scale, slime or sludge. Analogy is unworkable without a considerable reservoir of individual or organization experience.

Analysis of controllability also contains a large measure of experience, for the literature is limited in this new field, particularly with reference to overall systems of processes, including instrumentation. The fundamentals of process control are (1) material balance, (2) energy balance, (3) conditions of quality, and (4) conditions of economy. The first two are the necessary conditions of process workability; the last two are the sufficient conditions for economic operation (Haigler, in Marks "Mechanical Engineers' Handbook," 5th ed., 1951). In general, a control engineer may study a flow sheet to see that the first two conditions are met, without special knowledge of the process or traditional methods of operation. But, to meet the second two conditions requires specialized process operating information.

In a simple batch operation, material balance is settled by the batch nature of the process, but in continuous processes, particularly those with many streams entering or leaving the process, the maintenance of material balance may require much automatic flow and level control equipment. Some syntheses require extremely precise ratio control of materials.

Energy balance in a batch operation also may be relatively simple, but in a continuous operation it is almost certain to be a flow-control problem: the flow of gas, oil, steam or electricity, or cooling water, refrigerant or reflux.

Processes may be classified as either "bathtub" or "shower-bath" type. On a batch or bathtub process, so far as the heat balance is concerned, it makes no difference whether the hot and cold water are supplied simultaneously, intermittently, or one before the other. It is necessary only that

Author and Editors Invite You—

This article is written to emphasize an important fact. In spite of the general recognition that process instruments are process equipment—just as truly as a fractionating column or a heat exchanger—they are seldom treated that way. Much too often they are still being hooked onto the process almost as an after-thought, and often onto a process that was developed without much regard for controllability of its components.

The conclusion is inescapable that the correlation of process equipment and process instrumentation should commence at the beginning of process development and design. The idea of the process loop being closed by the instrumentation is not a new one, although it has recently been emphasized by developments in servomechanisms. But the time to close the loop is not when plant construction is finished. The time is the development stage when the interaction of equipment and control can be made to fit each other for optimum overall results.

The problem is not a simple one. The "system" approach advocated by the servomechanisms school may be an oversimplification so far as process industries are concerned. Perhaps the answer lies in the same approach that is used in chemical engineering itself—that of unit processes and unit operations. Already there is a fairly substantial literature dealing with control of heat transfer, fluid flow and distillation. But most other unit operations and practically all unit processes have been neglected in published papers with respect to their control aspects. The integration of unit processes and operations into complete processes is wide open territory in the literature of control.

Mr. Haigler's intention is to do what he can to fill this gap by means of future articles. But it is much more than a one-man job. Authors and editors agree that both instrument engineers and process engineers should be urged to contribute to the program—by correspondence, by suggestions, by literature references, by articles. Particularly is there an opportunity for chemical engineers familiar with the problems of control of unit processes to make a start in this important direction.

the total hot and cold are in the proper balance. On a continuous or shower-bath process, the flows of hot and cold must be continuously correct and steady.

Acceptable product may require that certain conditions of quality be held. For example, on a turboaltermator, the governor must not only handle the load variations but also maintain the standard frequency. In a conveyor rayon dryer, it is not sufficient that the material and drying air flow through, and that enough heat be added to evaporate the moisture. In addition, certain temperature and humidity limits must be maintained if the product is to be of consistent high quality in regard to strength, dye absorption, etc. Temperature is the most generally used condition of quality, but every industrial measurement may be used, including some of

the less usual ones such as pH, analysis, viscosity, dielectric and constant.

To maintain conditions of economy, further control may be necessary. More output with less material or energy, less waste or scrap, minimum corrosion, recovery of byproducts, and insurance of safety are usual objectives. In the previous dryer example, too much air would cause a waste of heat as well as reduced throughput. Many distillation columns are run at excessive reflux ratios which meet quality requirements but do it wastefully.

In readily reversible chemical and physical reactions the conditions of quality and economy may be so closely interwoven as to be difficult to distinguish. As concentrations and conditions are varied to change yield and throughput, quality also is likely to vary, with changing completeness of main and side reactions.

measurement is an unfortunate necessity. Not all factors that can be measured in a laboratory are susceptible to continuous measurement by industrial instruments. A definite chemical analysis may be the desired end result of a process, but usually some physical effect of the chemical variation such as boiling point, vapor pressure, conductivity, or pH may have to be used. Newer industrial measurements, such as infra-red absorption or oxidation-reduction potential, or even pH, practical under favorable conditions in one plant, may not be possible under other conditions in another plant.

Ordinarily the primary or causative variables—especially in continuous processes—are flows, liquid levels, pressures, temperatures, or humidities, all easy to measure. When the primary variables are controlled the need for measuring or controlling a difficult secondary variable may disappear. Preventing process upsets is more productive than trying to measure their consequences and then belatedly to offset them.

5. Considering Control Susceptibility—Considering susceptibility of a unit or a process to automatic control may be complex, but usually it can be analyzed into simpler elements. The important factors are (1) systematic response of control system and process; (2) the self-regulation of the process; and (3) the nature and magnitude of process lags.

FACORS IN SUSCEPTIBILITY

Systematic response, ranging from a significant measurement to a corrective medium flow and process response thereto, is necessary to secure good control. Unsystematic process response may come from attempting to operate a process in a region involving changes of state or reaction, or that is beyond the range of the equipment. Unsystematic control response may come from trying to control a secondary variable affected by an unstabilized primary variable; from a defect in the instrument installation; from friction caused by bad design, neglect, or mishandling; or from an inadequate and unstable supply of corrective medium.

Self-regulation of a process may be positive and helpful, neutral, or negative and upsetting. The self-regulating effect usually differs with different variables. Positive processes are inherently self-balancing, and the control has only to shift the balance point. Examples include: an open tank (or bathtub) through which water is flowing, where every rate of inflow results in a water level sufficient to produce a

Plotting Your Control Analysis

Procedure of control analysis will vary with the individual and the problem. However, with the above fundamentals in mind, a good routine is to:

1. List all process variables.
2. Define the magnitude, source and timing of changes in the variables.
3. Select significant variables.
4. Eliminate those not susceptible of measurement.
5. Consider susceptibility to control.
6. Settle on primary variables for control.
7. Settle on important secondary variables and consider them for cascaded control.

1. Listing Variables—All variables must be considered so that obscure ones may not be overlooked when they are important. Processes and operating conditions are becoming increasingly varied, so that one must look ahead, not back, in this work.

2. Defining Variables—This is a most important step. Are the changes large or small, sharp or gradual, regular or erratic? What combinations of changes can occur together? Which are so rare and unimportant as to be neglected? Sources or causes of variations must be understood, both in estimating the variations to be handled, and in the next and later steps of the routine of analysis.

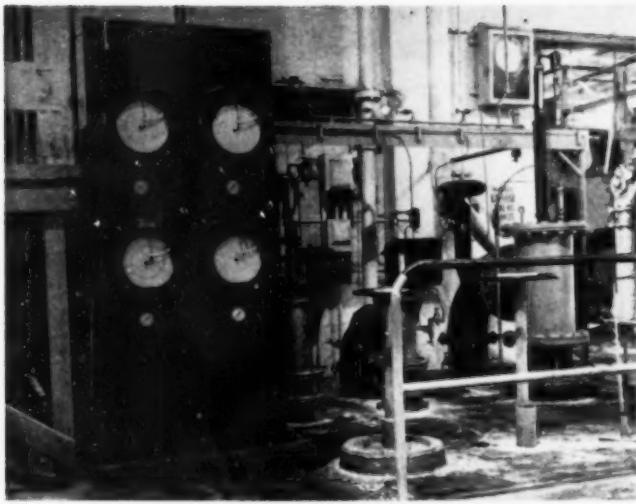
3. Selecting Variables—Selecting significant variables means first of all primary or causative variables, truly representative of changes in process conditions. They must not become constant, erratic, or non-quantitative under some operating conditions. They must not be changed or masked

by other variables. Often there are several primary variables present, each of which must be considered and controlled separately.

In a distillation column, separating a binary mixture into pure products, the temperature of the vapor leaving the top, or of the liquid leaving the bottom, is not significant in controlling reflux (heat extraction at the top), or heat supplied to the bottom of the column. These temperatures are constant while the separation is complete and are useful only as criteria of quality. But in the same column, if it is fractionating complex mixtures of graduated boiling point, these measurements may be significant. However, this is so only if the absolute pressure is held constant so that it does not change the boiling point and conceal the composition changes.

No secondary or resulting variable, however helpful it may be as recorded data, is significant for control until all primary variables have been stabilized. Often it may not be immediately obvious which are primary variables. For example, in a batch neutralization operation, pH is the primary variable, but the same pH measurement made in the same way with the same equipment is a secondary variable in a continuous process. There the solution flows and concentrations are the primary variables, and only when they have been controlled does the pH measurement become significant, chiefly as an indication that the primary controllers are stable and set at the correct values.

4. Eliminating Variables—Eliminating variables not susceptible of



Design for controllability starts with process development. Here water-purged transmitters taking measurements from variable-area meters, are used in three-way flow-ratio control of pulp blending.

matching outflow; or a continuous water heater where the temperature varies with the demand.

Neutral processes tend toward neither self-balance nor progressive unbalance. If the tank just mentioned were closed and under high gas pressure, there would be little self-correction, and any discrepancy between inflow and outflow would result in flooding or running dry.

Negative processes tend toward progressive unbalance. Exothermic chemical reactions which go faster and faster until explosion if the heat extraction fails, or endothermic reactions which go slower and slower until they cease if heat input fails, are examples which will occur immediately to the chemical engineer. But often there are other little suspected examples. Without positive pump circulation, oil in a cooler may increase in viscosity so fast that resistance to flow reduces the flow, in turn increasing the chilling until flow stops entirely. Or overheating an oil-cracking furnace without flow control, may cause coking, reduce flow further, and increase temperature until the tubes are plugged.

Process lags largely determine the transient phenomena of response, and hence the type of control mechanism required. Sometimes excessive lags may dictate a revision of process or equipment. There are four forms of lag: (1) transportation; (2) capacity; (3) transfer; and (4) instrument lags.

Transportation lag (sometimes called velocity-distance lag) is the time delay for the effect of an instantaneous change in a variable to be carried to a point in the system where it can affect the controller. For example, if a temperature-control bulb is located in a line remote from a heat exchanger, instead of at or in it, control action will be delayed by the time of flow from exchanger to bulb location. Such dead times are always harmful, and at low flows may become so large as to make automatic control quite impossible.

Capacity lag is a measure of the ability of a process or process element to store energy—mechanical, thermal, or chemical. A tank heated by direct steam injection has only a single pool of energy and is known technically as a single-capacity process; a single-pass heat exchanger is a two-capacity process. Capacity lags may be favorable or unfavorable.

Transfer lag results from the resistance to energy transfer between two capacities of a process. In the heat exchanger it comes from the thermal resistance of the heat-exchange surface. Transfer lag delays response of the measured variable to a process change. With transportation lag there is no response until the end of the transportation period, then a sudden full response. With transfer lag there is a small but increasing initial response, followed by a rapid rise, finishing off asymptotically—a so-called

S-curve response. Transfer lag is unfavorable, but less so than transportation lag.

Instrument lag has the general effect of additional process lag, usually of the nature of transportation or transfer lags. The measuring lags should be made negligibly small as compared with the process lag. (An exception is met in manometer flow-control applications where the instrument response may be somewhat slower than the almost instantaneous process response, but still rapid enough for control adequate to many purposes.) The control lag, which is measurement lag plus controller lag plus valve lag, should be brief compared with process lag. Instrument lags can be limited by proper selection, installation, and maintenance. Systems of interconnected (usually cascaded) controllers often are used to minimize effects of instrument lag.

Process lags likewise are not fixed and inevitable process characteristics. Their magnitude depends on the selection of the equipment and on its installation and operation. Transportation lags are minimized by proper location of the measuring element. Capacity lags often are easily altered by change in throughput, or operating levels, or equipment connections. Transfer lags are minimized by measures such as increased agitation, clean heat-exchange surfaces, and strictly countercurrent flows.

Complex combinations of lags can be analyzed into simpler elements, which then are attacked separately. Systems of interconnected instruments often are more effective in handling lags than independent controllers.

6. Choosing Variables for Control
—Settling on which primary variables are to be controlled, as mentioned above, is largely a flow-sheet analysis problem for material and energy balances. If the preceding data are complete and the analysis sound, this step is straightforward. Naturally, "control" of each primary variable does not necessarily mean an expensive recording controller. Perhaps a head tank or a centrifugal pump or simple pressure regulator will determine a pressure adequately, and so on for other variables. However, each item must be considered, and control to necessary limits for the required result be provided in one way or another. Modern instrument control will be the economic answer for many items.

7. Selecting Important Secondary Variables—This decision requires knowledge of the process, experience, judgment and often a good deal of
(Continued on page 208)

Push-Button Plants: When and How?

Tools and techniques for closing the automatic control loop are already available. Engineers and management need to know how best to apply them.

GEORGE A. HALL, JR.

Fully automatic—push-button—factories are coming fast, judging by present trends. This article explains what fully automatic control is; how it differs from other control techniques; why it is technically and economically valuable; what kinds of plans can now be so controlled; what kinds must wait, and why; what is holding up wide use of fully automatic control, and for how long; how it will affect process and product design, instruments, engineers, management, labor and John Q. Citizen.

Before we can sensibly discuss and evaluate push-button factories, we must go back and examine some fundamentals. Why do we build and operate processes? Why do we use automatic controls? What is the ultimate in automatic control? Where do we now stand historically in automatic control? With these questions answered, we can see where we are now, where we are going and how fast, and what it will mean to us when we get there.

Why do we build and operate plants? We do it to make goods, to create wealth, to make money. And the more goods and better goods we get per dollar spent, the better we think our plant is. In short, we build and operate plants to get the most and best product for the least cost.

Why do we use automatic controls? Basically, for these reasons: To save labor; to improve quality and efficiency; for safety to plant and personnel. In times past, the second reason far surpassed the first; the improvement of plant efficiency and product quality was the dominant reason for using automatic control.

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Until recently he was technical editor of Bristol's application engineering department. At the present he is engaged in problems of control applications.

This was well recognized by Luis de Florez in 1937 when he wrote:¹ "In the past, automatic mechanisms were viewed primarily as leading to reduced labor costs. Today, however, there is a constantly growing appreciation that they can be relied upon to carry out many operations far more accurately and reliably than is possible with the most skilled labor. The reduction of those errors caused by fatigue, poor judgments, and other inherent weaknesses in human control is of vital importance in the operation of processing units of great size."

More recently, the wider use of dangerous processes (for example, radioactive reactions) has given new importance to the use of automatic devices for safety reasons. So today, the saving of labor costs is a decidedly secondary reason for using automatic controls.

WHAT IS THE ULTIMATE?

To the instrument engineer, the ultimate in automatic control is the most automatic device—the one that relies least on human beings. But the true ultimate in automatic control, the factor of most importance to management, commerce and humanity, is that degree of control which yields the most and best product for the lowest cost. In short, the ultimate is the use of just as much automatic control as will earn its own keep.

Push-button factories should, and probably will come, only where and when they can pay their way. If instrument history repeats itself, push-button factories won't be used much for labor-saving reasons, but mostly to increase quality and efficiency.

Is there a trend toward fully automatic plants? Yes, definitely, and the trend is accelerating. Many authorities predict their wide use soon.

W. C. Uhl reports a chief instrument engineer of a leading oil company as flatly stating², "I predict our company will have a completely automatic refinery in five years." Uhl says further, "The automatic refinery will come, whether it takes five years, or ten, or more. It is merely a matter of time and ingenuity."

To others, there seems to be some doubt about how soon push-button

plants will come, and whether they will ever be completely automatic. For example: "In practice, the plant operator has, of course, continuously to supervise these 'robots' in order to make sure that they work satisfactorily. This supervision of instruments must be performed, regardless of the fact that the more elaborate control systems are supposed to work without fail."³

So this seems to be the picture—automatic factories, yes; but not at once, and probably not wholly without men, ever.

WHERE DO WE STAND HISTORICALLY?

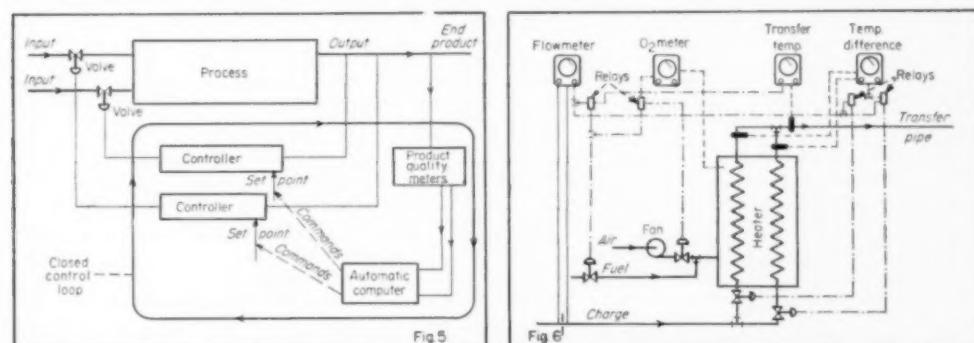
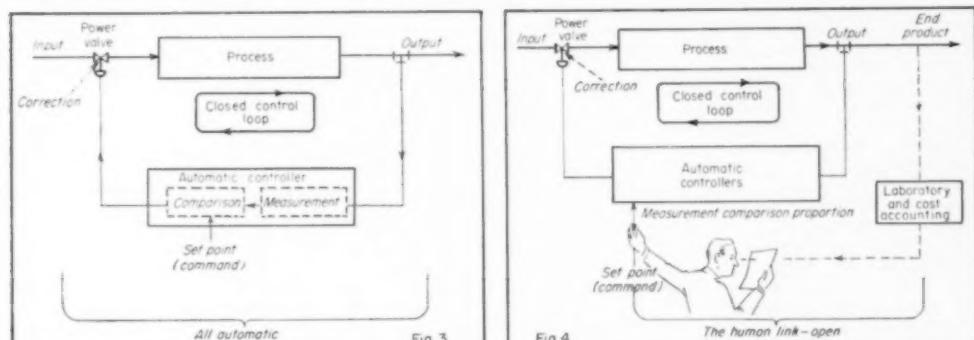
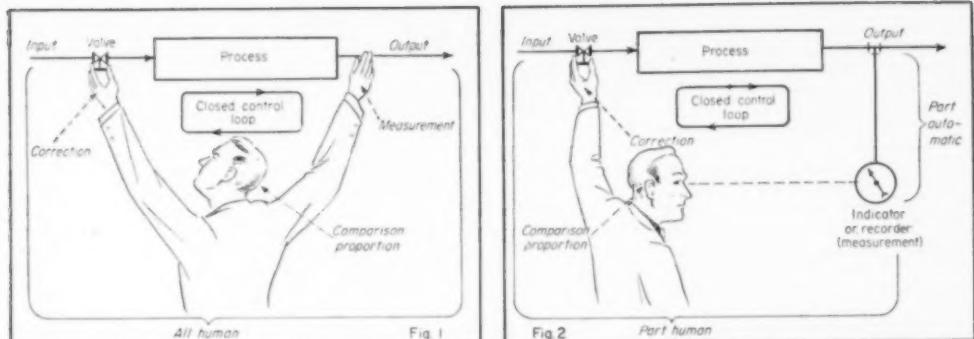
Before we get any further into push-button control, we should find out where we are now and how we got there. Then we can see where we're going and how fast.

The evolution of control took place in seven steps:

1. Manual control.
2. Indicating instruments.
3. Recording instruments.
4. Automatic controllers.
5. Centralized automatic controls and graphic panels.
6. Coordinated control systems.
7. End-product quality control systems.

Manual Control—This was the all-human control of a process without any instruments. These were the days of "spit-and-sizzle" measurement. The human operator sensed some process variable, like temperature or flow or color, by means of his own senses—touch, taste, sight, smell, sound. Then he decided what was to be done, and with his own hands built up the fire, shut off water, or threw in more chemicals.

Fig. 1 will help explain this. Suppose a man wanted to control a temperature process, for example. He might put his hand on a pipe coming out of the process (output) to see how hot it was (measurement). Then he would decide (comparison) if it was hotter or colder than he wanted (desired value). Then he would have to decide which way to turn the valve (polarity) and how much (propportion). Next, he would turn a valve (correction) to put into the process more or less heat (input).



EVOLUTION of automatic control is shown in Figs. 1 through 5; Fig. 6 is an example of coordinated control.

Then, after a time, the corrected input would change the output temperature. Our man would feel that and make another valve correction. So he would cut-and-try over and over, always getting closer to his desired value of temperature. His measuring, comparing, proportioning, and correcting actions would go round and round through himself and through the process in a closed chain or loop of control events, until at last he had the temperature in balance at the desired value.

CLOSED-LOOP CONTROL

It is important that we understand this closed-loop way of looking at control. The man with his senses, his brain and his muscles forms a self-correcting, error-sensitive system that could be applied to the control of any process. But there is nothing automatic about this, for the man forms all the links in the closed chain. Take the man away, and control would stop. We could call him a "servohuman"ism."

Indicating Instruments—The first link in the closed chain of control to be made automatic was the measurement function. Indicating instruments replaced fallible human senses with fast, accurate automatic measurements. Fig. 2 shows how part of the human link was replaced. The man here acts as "error detector" and "feed-back means" of the closed loop of control.

But control still called for plenty of operator judgment based on long ex-

perience. And these indicators gave only instantaneous information and did not provide data on past performance or present trends so essential to proper correction.

Recording Instruments—The operator's log-sheets and his guesses on trends were replaced by automatic recording instruments. Actually, recorders were just indicating meters, but they were continuous. They added memory, trend and rate of change to the data for use by the human operator. They helped the human link get better data faster. They greatly reduced the experience and judgment required of the operator. The comparing, proportioning and correcting control functions were still left to the human link.

Automatic Controllers—The invention of automatic controllers completed the replacement of human links in the closed loops of control. Fig. 5 shows how the functions of comparison, proportion, and correction, formerly done by the human operator, are done automatically. At this point, the "servohumanism" became the "servomechanism."

This was a tremendously important step, because it freed processes from the limitations of human operation. It was much more than just labor saving that was accomplished. Automatic controllers permitted successful operation of processes requiring control far beyond the ability of human beings to produce.

OPERATORS STILL NEEDED

Now, we've implied that automatic controllers eliminated human operators. Actually, not quite; it was still necessary for a man to go around to each automatic controller and adjust its set point. And the man still had to read the dials and charts to be sure all was going well.

Centralized Controllers—As more and more instruments were needed by larger and larger plants, the job of supervising their performance and adjusting their set points became both bigger and more difficult. So it was logical to bring all the instruments for each process together at one central point. This gave the plant a nerve center—the rudiments of a brain.

Since World War II, the great size of processes and complexity of their controls have required centralized instrument panels scores of feet long, with hundreds of instruments and up to eight or ten operators. With so many instruments so spread out, the assimilation of data was slow and confusing; the coordination of so many operators was almost impossible.

Great help to this situation has been given by graphic panels. Only data essential to operation are shown on the panel; all possible instrumentation is placed behind it or at the process. Data are presented compactly by miniature instruments; data are related to process functions by pictorial flow diagrams. In essence, the graphic panel is but a super-indicating instrument for giving more and better data faster to the human operator.

Even with graphic panels, the supervision—the thinking—is not automatic. When emergencies occur there is a race between the rate at which the emergency gets worse and the rate at which the operators can absorb data, analyze them, and come to decisions.¹

Coordinated (or Multi-Element) Control Systems were the first attempt at truly automatic plants. The thinking was automatic and built-in; the last human link—supervision—was more or less eliminated.

In coordinated control, the several individual controllers on a process are interconnected to form one correlated system. These interconnections may take many forms—pneumatic-set, electrical interlock, cycle timers, etc.—but they all accomplish the same thing: coordination between the individual controllers regulating the several variables of one process. In short, the individual controllers modify each other and, in rudimentary ways, the control system thinks for itself. Coordinated control involves the concept of a control system for a whole process, as distinguished from the use of several unrelated controllers.

A good example of how coordinated control differs from simple control is shown in Fig. 6. This involves the coordinated control of no less than five variables of a single process. Here's the problem: Control of flow to the two parallel coils must be done individually to compensate for coking and unequal distribution of combustion gases; temperature in the transfer pipe must be held at a set level; rate of charge must be held constant; fuel-to-air ratio must be controlled to maximum efficiency; the controls must operate the heater with complete safety.

HOW COORDINATED CONTROL WORKS

The basic control is the air output from the charge flow controller which positions the two valves in the two parallel heating coils and also regulates the fuel flow and forced draft air. A temperature-difference controller modifies this basic control by

means of an averaging relay so as to unbalance flow through the two heating coils in order to hold equal temperatures at the heater output. Impulses from the transfer temperature controller are combined with the basic control by an averaging relay to modify fuel and draft flow so as to hold the transfer temperature constant. The oxygen analyzer output is combined with the basic control output by another relay so as to regulate the forced draft supply for maximum combustion efficiency.

A study of more than twenty such coordinated control systems showed the frequent use of such words as *sum*, *difference*, *average* and *ratio*. These are all simple calculating functions; they can be called automatic thinking. Apparently, this automatic calculating is an essential feature of a true control system. In other words, the supervisory decisions left to human operators in simple centralized control are made automatically in coordinated-control systems; the last human link has been largely eliminated.

End-Product Quality Control is the seventh and last step in the historical development of control. The idea is simple: We control the plant directly from the desired qualities of the end product—not from several process variables that are only indirectly, inferentially related to product quality. In other words, we put end-product quality within the feed-back control loop.

This idea was emphasized by Brown and Campbell in 1950.² "It is our opinion that one should always strive for the most direct approach to the system-design problem, and whenever possible point one's effort toward explicit control of product quality."

ENVIRONMENTAL VERSUS QUALITY CONTROL

In the past, we have controlled a process by holding one or more of its variables constant. We have tried to keep the environment of the process at fixed values, hoping thereby inferentially to obtain the desired qualities in the end product. Even coordinated control systems were usually only multiple-variable environmental controls. We became obsessed with control to constant values, obsessed with fixed-set-point control. We left largely to the human operator the selection and adjustment of these set points.

But a constant, predetermined environment is not necessarily best for a process; a continuously corrected or modulated condition may be better.

If the basic justification for automatic control is to produce the most

of the best for the least, there is something missing in our environmental control. Again quoting de Florez:⁸ "Successful automatic control can be judged only by improved results. The mere fact of maintaining some variable condition constant . . . is of no service to the industry unless the control of this variable proves to be a governing factor in improving industrial results."

If quality and yield of end product are the basic aims in operating processes, why not control directly from end-product quality—why stop at controlling from environmental variables?

CLOSING THE CONTROL LOOP

What we have been calling "closed-loop" control actually is not closed at all. Fig. 4 explains this. The command or set point of the automatic controller is left to be manually set; a human link is still required to relate the set points of environmental controllers to the qualities of the final product.

What actually happens now in most plants is something like this: Samples of the end product are periodically carried to a laboratory. From there, in anything from an hour to a week, come reports on product quality and yield. At even longer periods come reports on plant efficiency, costs, etc., from production, purchasing and cost accounting. These reports are analyzed by human operators, who then adjust the automatic controllers to a new set of environmental process conditions.

In the meantime, the process has operated at less than optimum performance. All the human operators can hope to do during this open time is to hold process environment as close as possible to the previously determined set of conditions based on the most recent set of reports that were provided by the laboratory. The trouble, in short, is simply this—product quality, yield and cost are outside the automatic control loop.

What we must do is to put end-product quality inside the control loop; eliminate the human links to the last man; make quality control dominant over environmental control. Only thus can we achieve the ultimate in automatic control. When we have eliminated the last man and built plants that do their own thinking, we will have truly automatic push-button factories.

AUTOMATIC CALCULATORS

We have seen that the absorption and correlation of data by human operators is one of the chief difficulties with centralized and graphic

panel control. To eliminate human supervision, we must substitute automatic devices capable of absorbing, remembering and correlating large amounts of data at high speed. Automatic electronic calculators can do this.

In addition to merely replacing the last human link in the feed-back loop, automatic calculators can do a far better job, making possible yields, qualities and efficiencies previously impossible. T. R. Olive says:⁹ "Some (calculators) for example can solve relations that would be insolvable by ordinary techniques. Others get results quickly that would otherwise demand lengthy trial and error. Some are so accurate and so rapid that they permit the use of exact and detailed rather than approximate relationships. Thus, they produce a quality of result that otherwise might not be achieved in a lifetime of normal calculations."

If fully automatic plants are so desirable and electronic computers make them possible, what are we waiting for? Why don't we build them today? Many relatively simple processes now could be, and are, being built for fully automatic production. But for most processes, there are yet many problems to be solved—some technical and some managerial.

TECHNICAL PROBLEMS

Fast and Automatic Means for Measuring End-Product Quality—To measure quality, we must be able to define and evaluate its criteria. Such quality criteria as taste, feel, color, comfort, which mean so much to consumers, can, as yet, be only approximately and slowly measured and only by non-automatic laboratory methods. Even many more exactly established qualities, such as hardness, length of serviceable life, fading, tensile strength and particle size, are still measured by slow laboratory techniques. These measurements are too slow to be included inside an automatic closed loop of control.

But this technical problem is rapidly being solved. Automatic continuous titrimeters, viscosimeters, conductivity meters, infra-red, mass, and X-ray spectrometers have recently evolved from laboratory techniques. We must develop fast, automatic instruments to measure all necessary end-product quality criteria before any given process can be made fully automatic.

Process Design for Better Controllability—We must design processes with full regard for their control characteristics. The dynamics of many processes as they are built today are such as to make fully automatic con-

trol difficult or impossible. Probably a wider acceptance and use of frequency and time-response methods for analyzing process control characteristics will be necessary (see page 175).

Flexible, Reliable and Economical Computers—If each automatic computer is to be custom-designed and built for each control problem, its cost will be prohibitively high. For continuous operation of costly or dangerous industrial processes, automatic computers must be highly reliable. What is needed is a line of standardized, interchangeable, computer components that can be used in flexible combinations as simple or complex as the process requires, with plug-in parts for rapid maintenance. Such computers can be made both highly reliable and low in cost because they can be mass produced.

Relate End-Product Quality to Process Conditions—Process engineers and mathematicians will have to set up equations (solvable by computers) that relate optimum end-product qualities to the process environment that will produce such optimums. The difficulty of this problem will depend on the number of qualities of the end product that must be measured, on the number of variable inputs to the process that must be manipulated, and on the speed with which these factors can change.

For many simpler processes, these relations are now known or can be established by calculation or test. But for large, complex processes, developing equations for optimum performance will doubtless be a very difficult, even impossible task. Y. T. Li has described a method for experimentally determining these optimum relations.¹⁰ Briefly, his method is deliberately to swing the manipulated variables of the process back and forth by an amount sufficient to pass the end-product qualities through their optimum values. Then the process conditions that produce the optimums are noted and returned to for normal operation. A similar method could probably be used for experimentally determining equations for optimum conditions where the process is too complex for calculation.

Some factors affecting quality or efficiency can best be left to manual adjustment. For example, the effect of seasonal influences, like outdoor temperature, or such slowly changing factors as cost of fuel or of raw materials, could be left to a hand adjustment on the calculator or controllers. But faster changing factors affecting product quality, like atmospheric humidity, would have to be fully automatic.

MANAGERIAL PROBLEMS

While technical problems delaying push-button factories seem well on their way to solution, other less tangible industrial management problems may be tougher to solve.

Systems Approach by Engineering Management—Engineering departments are traditionally divided on functional lines: research engineer, development engineer, methods engineer, maintenance engineer, etc. But the engineering of push-button plants is going to require a new high in unified thinking by all engineers. It will require a departure from component engineering to systems engineering. This may pose a great challenge to engineering management.

It surely will require a new kind of engineer—whom Brown and Campbell¹ call the "systems engineer." He will have unprecedented authority to synthesize and unify the over-all performance of the several engineering departments, whose interests are often opposing. How fast this problem will be solved depends on the understanding by top management of the basic requirements of systems engineering.

Education of Business Management—This problem can be solved by the engineer himself. One vital function of the engineer in industry is to keep his business managers informed of the latest technical advances. When management is made aware of the economic advantages actually possible with fully automatic plants, they will be quick enough to provide funds and authority to design and build such plants.

PRESENT POSSIBILITIES

What kinds of processes can be made fully automatic now? This is probably the most interesting and frequently asked question in the whole subject of automation. To answer it, we must classify all processes into two groups:

1. **Fluid Flow Processes**—Those involving fluids—liquids, gases, electric current—or solids in crushed or powdered form that can flow in continuous streams.

2. **Discrete-Unit Processes**—These are the processes involving solids in discrete units, such as a garment, a radio set, or an ingot of steel. Obviously such discrete units cannot flow like a fluid but must be individually handled, one by one.

Two factors make fluid flow processes easy to automatize fully:

The ease of controlling transfer, manipulation and storing of fluids; the ease with which fluid flow plants can be made completely continuous in operation.

As evidence of this, it is mostly in the continuous fluid flow processes where a high degree of automation has already been achieved; for example, petroleum refineries, chemical plants and electric power generating stations. In these plants full automation—push-button operation—usually requires only the elimination of the last human supervision and the substitution of end-product quality control by calculators. Very few changes, if any, will be required either in the fluid flow plant itself or in its product to convert it to fully automatic control.

SOME MUST WAIT

What kinds of plants must wait for push-button control, and why? In contrast to fluid flow processes, discrete-unit processes present many difficulties in transferring, manipulating and storing their materials. Compare the difficulty of controlling the rate of flow of, say, men's coats between a storeroom and a pressing machine with the ease of controlling the rate of flow of fuel oil moving from storage tank to burner.

Materials handling of discrete units usually involves complex and special conveyors, special storage racks or fixtures, custom-made jigs and chucks. And in many plants, different fixtures must be used to hold and convey the work at each step of the process.

To make all these conveyors, racks and fixtures completely automatic requires custom engineering and highly specialized mechanisms. All of this creates two serious deterrents to full automation: Inflexibility of plant because of the very special design of materials handling and holding fixtures; extremely high cost of automation because of the special engineering and custom-made equipment required.

Many very successful attempts have been made to fully automatize discrete-unit processes. If you have ever watched a machine for forming, capping, labeling, filling and sealing tooth-paste tubes, or a brewery bottling-washing, sterilizing, filling, capping, pasteurizing, labeling and crating machine, you know how automatic such discrete-unit processes can be made.

But these two processes illustrate exactly the difficulty of automation of discrete-unit plants. Both machines are specially designed and built for one task only. The change to a different shape or size of container, or a different form of closure, would usually require extensive refitting and lengthy shutdown. Therefore, only very long runs of identical product makes such automation economically possible for discrete-unit processes.

Unfortunately for the automatic

control engineer, a great many of our discrete-unit products cannot be so mass produced. For one thing, many of them are never made in sufficient quantity to warrant the great capital investment for a special automatic machine. Also, consumer preferences for variety, seasonal market variations, changes in styles, or the merchandising demand for constantly changing sales features, all prohibit long runs and the use of inflexible processes for many products.

However, an answer to this problem is technically possible, according to John T. Diebold.² An alternative solution which we believe to be very practical is the utilization of standard production machines for the fabrication function and the linking together of these units with automatic materials handling equipment for the achievement of automation. Individual automatic controls will be used on the production machines, while an over-all system of control can be provided by use of a small digital computer. This solution permits a very flexible setup—with machines easily rearranged for the production of another product—and the use of fabricating units which can be mass produced. The problem of obsolescence is minimized, while a high degree of automation is attained."

But such a solution will present many problems that will require much engineering and time. So, many discrete-unit processes must wait for full automation until difficult problems of materials handling are solved. How long depends on the ingenuity of engineers and the vision of business executives.

PLANNING A PUSH-BUTTON FACTORY

The steps for planning fully automatic factories have been well defined by now. The order of planning is as important as any single step. Too many instrument engineers are gadget-minded—obsessed with the importance of this or that device. So they bog down in Step 5, because they skipped the first four steps.

1. Draw a functional block diagram of the proposed process, identifying each operation, its inputs and outputs.

2. Re-examine both process and product to see if they are as susceptible to full automation as possible. Here's where the dynamic characteristics of your plant come in. Plenty of experience with performance of existing similar plants may be the best guide here.

3. Define the criteria of end-product quality and select instruments capable of sufficiently rapid, accurate measurement of these criteria.

4. Decide which environmental variables of the process are to be held constant and which are to be manipulated in order to produce the desired end-product quality.

5. Select automatic measuring and controlling instruments capable of fixing or manipulating the selected environmental process variables.

6. Develop an equation relating environmental process variables to end-product quality criteria. Calculations or simulated processes, using an analog computer, may sometimes derive this equation, but often tests on existing plants will be the only way to get this information.

7. Design an automatic computer which will continuously solve this equation. The computer must continuously receive data on all product quality criteria and continuously calculate and generate commands that manipulate the selected environmental process variables so as to hold product quality within required tolerances.

And when you've successfully planned all these above seven steps, you may have to throw the whole idea out because of Step 8.

8. Figure out whether your push-button plant can earn its own way. If it won't pay off, you'll have a hard time selling it to your boss.

What will push-button factories mean industrially, economically, socially? Let's try to make a quick rundown of what full automation may do to our future. Such predictions may be fanciful, but they are too exciting to omit here.

TECHNICAL IMPACT OF AUTOMATION

Processes—We must learn to think in circles—closed loops—and forget component-by-component design; learn that the process and control are a single unit; learn to synthesize, as well as analyze, unit processes. Many processes will require basic redesign based on frequency and time-response analyses.

Products, too, will often require design or redesign for automation. A re-evaluation of the end use to which the product is put will often be necessary. Lower prices possible through automation may reconcile the user to necessary product changes. We've met this problem before and solved it in all mass-produced products. For example, few people today mind the standardization necessary for mass production of automobiles, because of their low price compared to the custom-built car.

Instruments—There will be an eventual end to the use of indicating and recording instruments and graphic panels, simply because there will be no one left to look at them. Record-

ers will survive only for their accounting function. Most of our present controllers, being originally designed for indicating or recording, lack the dynamic response needed for full automation. A strong trend toward separation of control and indicating and recording functions is already evident in the miniature remote pneumatic and electronic control systems.

If plants are to be fully automatic, safe and efficient startup and shutdown will be responsibilities of the instruments. This is in contrast to the usual practice today, where large and complex plants are started up and shut down under manual control. And, if full automation is achieved, still another automatic function must be included—the ability of the control system to report and correctly act on its own failures.

IMPACT ON SOCIETY

Business Management today must concern itself with much more than profits. As full automation progresses, personnel problems will be more difficult; workers will resent displacement; orderly methods for worker transfer will have to be devised; the costs of worker retraining must be absorbed. Skillful advance planning at the top executive level will be required.

The newest plants will have an even bigger edge than before over the old, because, in many cases, existing processes can't possibly be converted to automation at all. The automatic factory will have to be designed for automation from the drafting board up. This will require heavy capital investment that may put the smaller firms at an insurmountable disadvantage and well may tip the balance further in favor of big business.

Ripples from push-button factories will be loud and long in the public relations field. Already we have sensational statements in every field of journalism—lurid stories ranging from dire predictions of manless factories to irresponsible forecasts of workless utopias.

These journalistic sprees will disturb the average American very little. He's used to having his credulity stretched by exaggerated reports on the wonders of science. But a sober public relations program will doubtless be needed to allay many needless fears and to educate the public to the ultimate over-all benefit of push-button plants.

Labor and Unions—A century ago, labor reacted hard to labor-saving machines. What will its reaction be to machines that dispense

with labor altogether? We may expect plenty of attempts at restrictive union contracts and anti-push-button legislation. And unions are enjoying an increasingly potent influence on legislation.

The advent of automatic factories may require labor unions to evolve new yardsticks by which to gage their wage demands. In the past, as each technical advance increased production efficiency, labor claimed for itself a share in such increased earnings. But how can this principle be applied to push-button plants, where there is no labor left? On the other hand, if push-button factories lower the cost of goods, labor's cost-of-living yardstick will be shrinking at the very time profits are rising and the market for labor is falling.

This vitally concerns management, too. For how can management sell its automatically made goods when its former customers have largely lost their jobs to the automatic machines? Mass production is impossible without mass consumption. New ways may have to be found to distribute broadly the wealth created by automatic factories.

Sociology—Already, the new idea of feed-back control has social implications far beyond the field of engineering. Feed-back concepts provide valuable new approaches to problems in physiology, neurology, psychology, economics and even philosophy.

The whole of human society can be thought of as a vast, closed control loop, where man's perception of present social and economic wrong is the error signal fed back as correction to his future actions. Isn't it possible that the study of human society in the light of feed-back theory would reveal many openings in the closed loops, where our social or economic systems fail because there is no feed-back, or because the feed-back is too slow for the dynamics of the system? Thus, ideas discovered by feed-back control technologists may provide new ways for analyzing and solving the social problems of the future.

REFERENCES

1. Brothman, A., and Ramani, R. V., *Chem. Eng.*, Nov. 1949, pp. 114-117.
2. Brown, J. S., and Campbell, D. P., *Mech. Eng.*, Feb. 1950, pp. 124-127.
3. De Flores, Luis, *Ind. Eng. Chem.*, Nov. 1937, pp. 1210-1211.
4. Diebold, John, "Making the Automatic Factory a Reality," report by student group, Harvard Business School, May 15, 1951.
5. La, T. T., *Instruments*, Jan. 1952, p. 72.
6. Olive, T. R., *Chem. Eng.*, Dec. 1950, pp. 117-120.
7. Uhl, W. C., *Petr. Proc.*, Oct. 1950, pp. 1064-1067.
8. Walter, Leo, *Chem. Age.*, Aug. 19, 1950, pp. 254-257.

either intuition or hindsight. Generally these secondary variables should be recorded. When control is needed, cascading to a primary variable controller is usual. In a fractionating column, for example, the primary variables will be flows, but temperature controllers may set the flows of reflux and heat input, or bottom product.

Attempts to control the secondary variables without cascading were very common in the German chemical industry as investigated in 1945. Generally they were not only unsuccessful, but seriously upsetting. We know that the flow controllers cannot be omitted on continuous processes. Increasingly, secondary variables are used for setting the ratio of ratio-flow controllers to attain still greater accuracy, rangeability and responsiveness.

Evaluation of controllability by analogy or analysis has been discussed but both evidently have practical limitations. Analogy, though quick, cannot be projected with certainty very far beyond actual experience. Analysis, when complete, takes much time, skill and experience. But what about a combination of these methods, via the unit operations? The concept of unit operations and unit processes makes it possible to break down an almost infinite number of operating processes into a relatively few components. Major instrument application problems now seem to center about controllability of the process as whole, the design of units of equipment in the process, and the selection of suitable control variables. The approach should no longer be that of selecting individual control mechanisms, once the needed measurements are settled. Therefore, control analysis by unit processes and operations would appear to be a fruitful field. If it proves possible to publish the basic principles of control for each unit process and operation, along with the principles for the integrating of such unit processes and operations into working processes, then the application of instrumentation in process industries will be able to proceed with much more of routine scientific certainty, and much less of trial and error or the artistic judgment of the experienced few, than is possible at present.

Perhaps too, if the importance of equipment design for controllability can be more clearly presented, new designs will take fuller advantage of the possibilities of increased capacity and improved performance through instrument control.

What the Words Mean

In spite of many efforts to standardize on language in the automatic control field, there are still cases where words are misunderstood. Here are simple definitions for a few.

The fact that we offer here a small glossary of our own, with definitions sometimes ours, sometimes those of others, is no reflection on the efforts of organizations such as the Industrial Instruments & Regulators Division of the A.S.M.E., the I.S.A. and the A.I.E.E. Our purpose is simply to provide a few short, easy-to-follow explanations of a few of the terms in automatic control terminology which are most often encountered and most often misunderstood.—EDITORS.

Accuracy: Value defining the limits of error of a measurement, usually in percent of instrument scale.

Automatic control: Maintenance of a desired value of a variable within prescribed limits, or varying the maintained condition according to a desired time-quantity relation.

Automatic controller: Mechanism which measures the variable and operates to correct or limit deviations from a desired value.

Capacity: Measure of the maximum quantity of energy that can be stored. (One-capacity, two-capacity process: processes with only one, or only two, energy storages.)

Cascade control: Automatic control in which one automatic controller adjusts the control point of another automatic controller.

Control point: Value of the controlled variable which the automatic controller operates to maintain.

Dead time: A definite delay period in measurement, control or process. See process lags.

Derivative response (action, mode): Mode of control in which final control element moves at a rate proportional to the rate of deviation of the variable from the control point.

Droop: Shift in control point with change in load due to an inherent characteristic of the automatic controller.

Deviation: Instantaneous difference between the value of the controlled variable and the control point.

Error: Deviation; or instantaneous difference between "feedback" and control point.

Feedback: Signal from the process to the controller showing instantaneous value of the variable. Controller then measures "error" and acts on it.

Final control element: Valve, damper, switch, rheostat or other device actuated by controller for maintaining controlled variable.

Floating response (action, mode): Control mode in which the final control ele-

ment moves at a rate proportional to deviation of variable from control point.

Force balance: Applied to controllers, this means balance of a force proportional to value of the variable, against an equivalent pressure which can be used for indication and/or control.

Frequency response: Method of analyzing characteristics of instruments or processes which consists in applying a recorded sinusoidal variation and then recording the output to compare phase and gain.

Gain: Amplification or attenuation of response to a change.

Lag: Any retardation or dead time of response in process or instruments. Transportation lag; delay in "knowledge" of a change by the primary sensitive element. Capacity lag: retardation due to storage capacity in process. Transfer lag: retardation due to a barrier between capacities—a resistance. Instrument lags: Any lag between primary sensitive element and final control element.

Load: Process condition to be held, generally by energy transfer.

Offset: See droop.

Precision: Closeness of agreement of repeated measurements of same quantity.

Primary sensitive element: Device which senses changes in value of a process variable. It may, or may not, measure magnitude of the change.

Proportional response (action, mode): Type of control which adjusts the final control element to a definite relation with the measured value of the process variable.

Proportional band: Range of values of the measured variable which will cause change in final control element throughout its entire span.

Range: Maximum limits of an instrument.

Rangeability: Range of maximum to minimum change that can be made by a final control element.

Reset: See floating control. A mode of control used with proportional controllers to prevent droop with changes in load.

Regulator: See automatic controller.

Sensitivity: Ratio of effect to cause in an instrument.

Servomechanism: Type of automatic controller which maintains a position in a desired relation to an input quantity.

Span: Limits of measurement between which an instrument is designed to operate. (See range.)

Throttling control, range: See proportional response, band.

Time constant: Time for exponential change to reach 63.2 percent of final value.

Transducer: Broadly, any device for converting one form of energy (or position) into another.

Variable: Physical quantity which varies with time.

which of these do you handle?

ACIDS (INORGANIC & ORGANIC)		Maximum Temperature, deg. C.	SOLUTIONS OF INORGANIC SALTS AND ALKALIES		Maximum Temperature, deg. C.
Recommended	HR = Hard Rubber		HR-SR	HR = Hard Rubber	
Acetic	HR	70	Sodium (or potassium) hydroxide	HR-SR	70
Acetic Anhydride	HR	70	Sodium (or calcium) hypochlorite	HR-SR	70
Arsenic	HR-SR	70	Sodium sulphate	HR-SR	70
Boric	SR	40	Sodium (or potassium) sulphide	HR-SR	70
Citric	HR	70	Sodium (or potassium) sulphite	HR-SR	70
Formic	HR-SR	70	Sodium thiosulphate	HR-SR	70
Hydrochloric	HR	70	Stannous chloride	HR-SR	70
Hydrofluoric (up to 50%)	HR-SR	70	Stannous chloride	HR-SR	70
Hydrofluosilicic	HR	70	Sulphite Liquors	HR-SR	70
Hydrogen sulphide water	HR	70	Zinc chloride	HR-SR	70
Lactic	HR	70	Zinc sulphite	HR-SR	70
Nitric (up to 20%)	HR-SR	70			
Oleic	HR	70			
Oxalic	HR-SR	70			
Phosphoric (up to 85%)	HR	70			
Salicylic	HR-SR	70			
Stearic	HR	70			
Sulphuric (up to 50%)	HR-SR	70			
Sulphurous	HR-SR	70			
Tartaric	HR-SR	70			
Tannic		70			

SOLUTIONS OF INORGANIC SALTS AND ALKALIES		Maximum Temperature, deg. C.	HALOGENS		Maximum Temperature, deg. C.
Recommended	HR-SR		Chlorine (dry) at low pressures	HR-SR	
Aluminum chloride	HR-SR	70	Chlorine water (hypochlorous acid)	HR-SR	70
Aluminum sulphate	HR-SR	70		HR-SR	70
Alum	HR	40			
Ammonium hydroxide	HR-SR	70			
Ammonium sulphate	HR-SR	70			
Barium chloride	HR	70			
Brine (acid)	HR-SR	70			
Calcium bisulphite	HR-SR	70			
Calcium chloride	HR-SR	70			
Calcium hydroxide	HR	70			
Cupric sulphate	HR-SR	70			
Cupric chloride	HR-SR	70			
Ferric chloride	HR-SR	70			
Ferric sulphate	HR-SR	70			
Ferrous chloride	HR-SR	70			
Magnesium chloride	HR-SR	70			
Mercuric chloride	HR-SR	70			
Plating solutions	HR-SR	70			
Brass, Cadmium, Copper, Gold, Lead, Nickel, Silver, Tin, Zinc	HR	70			
Potassium Dichromate	HR-SR	70			
Sodium (or potassium) bisulphite	HR-SR	70			
Sodium (or potassium) bisulphite	HR	70			
Sodium cyanide	HR-SR	70			

ORGANIC MATERIALS		Maximum Temperature, deg. C.	ACE® RUBBER- PROTECTED EQUIPMENT		Maximum Temperature, deg. C.
Recommended	HR-SR		HR	HR-SR	
Acetalddehyde		70			
Acetic anhydride		70			
Acetone		70			
Alcohols		70			
Ammonium Thioglycolate		70			
Amyl, butyl, ethyl acetates		70			
Aniline hydrochloride		70			
Castor		70			
Castor Oil		70			
Cocoonseed Oil		70			
Cottonseed Oil		70			
Dyesstuffs		70			
Ethers		70			
Ethylene glycol		40			
Formaldehyde (up to 40%)		40			
Furfural		70			
Fruit juices		70			
Glucose		70			
Glycerine		70			
Ketones		70			
Milk		40			
Mineral Oils		70			
Olive Oil		70			
Soaps		70			
Triethanolamine		70			
Vinegar		70			

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... and this is only the beginning. This list represents only a few of the actively corrosive solutions which can be handled economically by Ace rubber protected equipment. Ace Tempron, Neoprene, nitriles, copolymers and Ace Thermoplastics such as saran, polyethylene, etc., extend this range still further.

Ask our engineers to recommend the most economical corrosion-resistant equipment for your processes.



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NEW PACKAGING & HANDLING EQUIPMENT



TOTE BIN is designed for easy handling with maximum protection of contents.



TOTE TILTER is used for unloading of the bins; rounded corners facilitate discharge. Other special equipment is used for filling.

Portable Bin Boxes Handle Bulk Solids

Between plants or within a single plant, the Tote System offers a new approach to one of industry's most important problems—materials handling.

Having firmly established itself in the food industry during the past two years, the Tote System is now being offered to the chemical process industries as a novel method of handling bulk solids. Installations in the chemical field are already handling synthetic detergents, carbon black, phthalic anhydride and polystyrene. This list is certainly going to grow rapidly, according to present indications.

The Tote System is based on the carefully designed Tote Bin, illustrated above, along with three other basic pieces of equipment. The Tote Jolter and Spinner Head are used for filling the bin, while the Tote Tilt (also illustrated) is a special mechanism which converts the bin into a 45-deg. angle hopper for quick discharge of its contents.

BIN DETAILS

The Tote Bin comes in a standard size (Type A-74), measuring $42 \times 48 \times 68\frac{1}{2}$ in. high. It stands on 4-in. legs; this slight elevation lets you handle the bins with standard fork

lifts or pallet trucks. Type A-74 has a tare weight of 225 lb. (in aluminum construction) and a load capacity of 3,000 to 4,000 lb. Volumetric capacity is 74 cu. ft.

A smaller bin, Type A-42, is of the same basic design with a capacity of 42 cu. ft., or 1,500 to 2,500 lb. It measures $42 \times 36 \times 52\frac{1}{2}$ in. and weighs 165 lb.

Designed to conserve space in storage or in transit, 22 A-74 bins fit into a 40-ft. car or 28 into a 50-ft. car. Trucks can carry as many as 18 bins per load.

Here are some of the other advantages claimed for the Tote System:

- If you are now using bags or other disposable containers for handling materials between process buildings or different plants, you stand to save substantially in container costs.

- Product loss resulting from bag breakage, sifting or by dumping loss is said to be virtually eliminated.

- Handling labor can be greatly reduced. A carload of Tote Bins can be unloaded with less than 1 man-hr., it is claimed.

Some of the Tote System case histories make interesting reading. For example, a certain bakery buys most of its flour from a mill 60 mi. away. A truck driver leaves the bakery first thing every morning with 10 empty bins. He goes to the mill, leaves the empty bins, picks up 10 loaded bins and is back and unloaded just after noon.

A synthetic detergent plant uses Tote for providing temporary storage while awaiting laboratory analyses. Bins from various lots can then be blended to give a uniform finished product. The Tote System is also being used to handle material between processes and for in-plant blending operations.

A large plant producing intermediates and dyes is reported to be considering a Tote System for distributing salt to various scattered points of use. Salt is now received in bulk, then put into paper bags for distribution within the plant. The proposed system would eliminate the cost of bags and spillage and reduce handling labor.

A logical extension of the Tote idea is the handling of liquids in suitably designed bins. A modified Tote Bin is now being put into such a service.—Tote System, Inc., Beatrice, Neb.

Equipment Cost Indexes

(Marshall and Stevens Indexes of Comparative Equipment Costs, 1926 = 100)

Industry	Mar.	Dec.	Mar.
Average of all	1951	1951	1952
Cement mfg.	174.0	169.5	172.8
Chemical	182.0	177.5	180.8
Clay products	169.0	164.5	167.8
Glass mfg.	172.1	167.6	170.9
Paint mfg.	175.3	170.8	174.1
Paper mfg.	175.6	171.1	174.4
Petroleum Ind.	180.8	176.3	179.6
Rubber Ind.	180.8	176.3	179.6
Process Ind. avg.	179.4	174.9	178.2

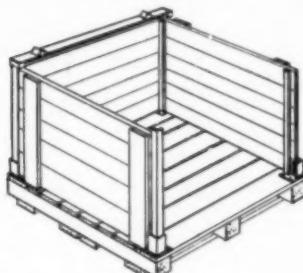
Process Industries

Cement mfg.	174.0	169.5	172.8
Chemical	182.0	177.5	180.8
Clay products	169.0	164.5	167.8
Glass mfg.	172.1	167.6	170.9
Paint mfg.	175.3	170.8	174.1
Paper mfg.	175.6	171.1	174.4
Petroleum Ind.	180.8	176.3	179.6
Rubber Ind.	180.8	176.3	179.6
Process Ind. avg.	179.4	174.9	178.2

Related Industries

Elec. power equip.	183.6	179.1	182.4
Mining, milling	182.7	178.2	181.5
Refrigerating	201.0	195.8	200.3
Steam power	171.3	166.7	170.0

Compiled quarterly for March, June, September and December of each year by Marshall and Stevens, evaluation engineers, Chicago and Los Angeles. Indexes are prepared for 45 different industries, from which the eight presented at four related industries listed here are selected. Published each month with the latest available revision. For a description of the method of obtaining the index numbers see R. W. Stevens, *Chemical Engineering*, Nov. 1947, pp. 124-6. For a listing of annual averages since 1913 see *Chemical Engineering*, Feb. 1952, p. 191.



Stacking Box Has Many Uses

This new device can be used as a stacking box, stacking bin, or stacking pallet, and is easily and quickly knocked down and bundled for shipping.

It consists of a heavy-duty wood pallet and four interlocking wood side panels held in place by four structural posts which slip-fit into angle sockets secured to the corners of the pallet with four lag screws. Angle cross bars with alignment angles and end closures slip-fit over the top of these posts to support the box above.—Paltier Corp., 1701 Kentucky St., Michigan City, Ind.

Stainless Conveyor Belt Of Giant Dimensions

What is claimed to be the widest polished, one-piece stainless steel conveyor belt ever fabricated has just been completed. This belt, with its special transverse welded joint, was 55 in. wide by over 100 ft. endless length.

The outer surface was finished to

IN BRIEF—A capsule listing of this month's newsworthy equipment.

Packaging and Handling Equipment

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a mirror polish. The welded area was finished to the same thickness as the basic belt and then polished also.—Metalsmiths Div., Orange Roller Bearing Co., Orange, N. J.



Bag Holder With Positive Grip

Holding the bag is an important function in bag-filling operations, and this new self-locking cam-grip holder is designed to do so with a positive grip. It comprises a bag-holding mechanism mounted on a spout

which you bolt to the hopper or bin outlet. Empty bags are simply slipped over the mouth of the spout and up under the cams.

When releasing a filled bag, you push up on a semi-circular release bar releasing the cams and allowing the bag to drop to conveyor or skid. The device is used with 50, 80 and 100-lb. multi-wall paper bags.—Richardson Scale Co., Clifton, N. J.

Screw Conveyors Have Smooth Surfaces

Absence of lap joints and crevices features a new line of sanitary screw conveyors. The joint between the flight and the pipe shaft is continuously welded both sides of the flight; the welds are ground to a smooth fillet and polished to a No. 4 finish. The screw has a smooth continuous surface from one end to the other.

This type of screw is offered in any standard or special size from 1 to 16 in. diameter in any pitch, thickness and shaft diameter. It is available in

stainless steel, aluminum and other metals and alloys, separately or in conjunction with complete systems including hoppers, feeders, troughs, drives and spouts.—Kornylak Engineering Corp., 513-521 Communipaw Ave., Jersey City 4, N. J.

NEW ELECTRICAL & MECHANICAL EQUIPMENT



Continuous V Packing Is Cut On the Job

A new continuous V or chevron packing, designed for 500 to 6,000 psi., is furnished in 25-ft. spirals for cutting to size on the job. For a given packing size, a single stock item fits any diameter stuffing box, eliminating the need for stocking a number of different sets of packing.

The new packing is made in sizes from $\frac{1}{4}$ to 1 in., by $\frac{1}{8}$ -in. increments. No. 2005 is constructed of asbestos cloth and neoprene and is recommended for high-temperature service on reciprocating steam or air rods, hot oil pumps, etc. No. 2008—for lower temperatures—is made of cotton duck and neoprene and is for hydraulic rams, outside-packed plunger pumps, etc.—Flexrock Co., 3670-B Cuthbert St., Philadelphia 4, Pa.

Pipe Threading Machine With New Die Heads

The recently announced Rigid 500 pipe and bolt threading machine features new types of self-contained die heads which are said to reduce the first cost and make sizeable savings of work and time.

The Quadratype head is instantly adjustable to thread 1-in. to 2-in. pipe, including over and under size, regardless of position of quick-opening lever and without removing dies or die head from the machine. Dualtype heads, one for $\frac{1}{4}$ -in. and $\frac{1}{2}$ -in. and one for $\frac{1}{2}$ -in. and 1-in., offer this same instant size change right in the machine. Monotype die heads, $\frac{1}{4}$ -in. to 2-in., and bolt die heads, 1-in. to 2-in., which adjust to over and under size

Power Shovel Loads While Standing

An advantageous operating feature of a new power shovel is that it can be loaded while the tractor is stationary. The machine can also be used for vari-

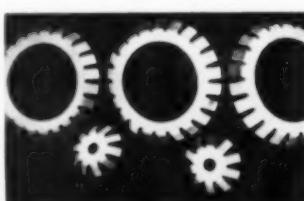
ous other types of work by changing the shovel for other attachments, such as backfiller blade or crane lift. Changes are made easily, without even using a wrench; you simply remove four pins.—Lessmann Mfg. Co., Des Moines 4, Iowa.

in the machine, are also available.—Ridge Tool Co., Elyria, Ohio.



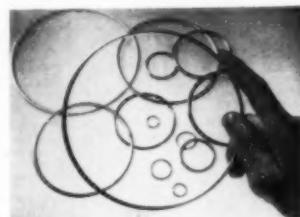
Volt-Ammeter Combines Two In One

The well known Tong Test ammeter can now be provided with a combination arrangement which permits you to make voltage measurements with the same instrument. Voltage leads are quickly and safely plugged into the handle. Two voltage ranges are available, 0-150 and 0-600 v.—Columbia Electric Mfg. Co., 4553 Hamilton Ave., Cleveland 14, Ohio.



Cup Expander Adds to Packing Efficiency

A new cup expander, designated ES-11, is designed to reduce leakage in hydraulic and pneumatic cylinders. It assists the sealing action of the cup packing at all times by exerting controlled pressure on the packing lip so that it maintains constant contact with the cylinder wall. These expanders are recommended for use on pumps, compressors, hydraulic presses, air cylinders, etc.—HPL Mfg. Co., 15141 Miles Ave., Cleveland 28, Ohio.



Metallic O-Rings Are Pressure-Filled

A new type of O-ring is made of hollow metal tubing, filled with inert gas at 600 psi. It can be used against pressures as high as 20,000 psi. and withstands temperatures and chemicals within the properties of the metal.

This development means that you can now use O-ring seals at high temperatures and in contact with oils and solvents which would attack rubber and other organic materials. Resistance to acids and other chemicals is provided by using stainless steel, or mild steel with cadmium or nickel plating.

These rings were invented in England and have been in use there for several years on diesel engines, air compressors, vacuum equipment, and many types of fuel and hydraulic applications.—United Aircraft Products, Inc., 1160 Bolander Ave., Dayton, Ohio.

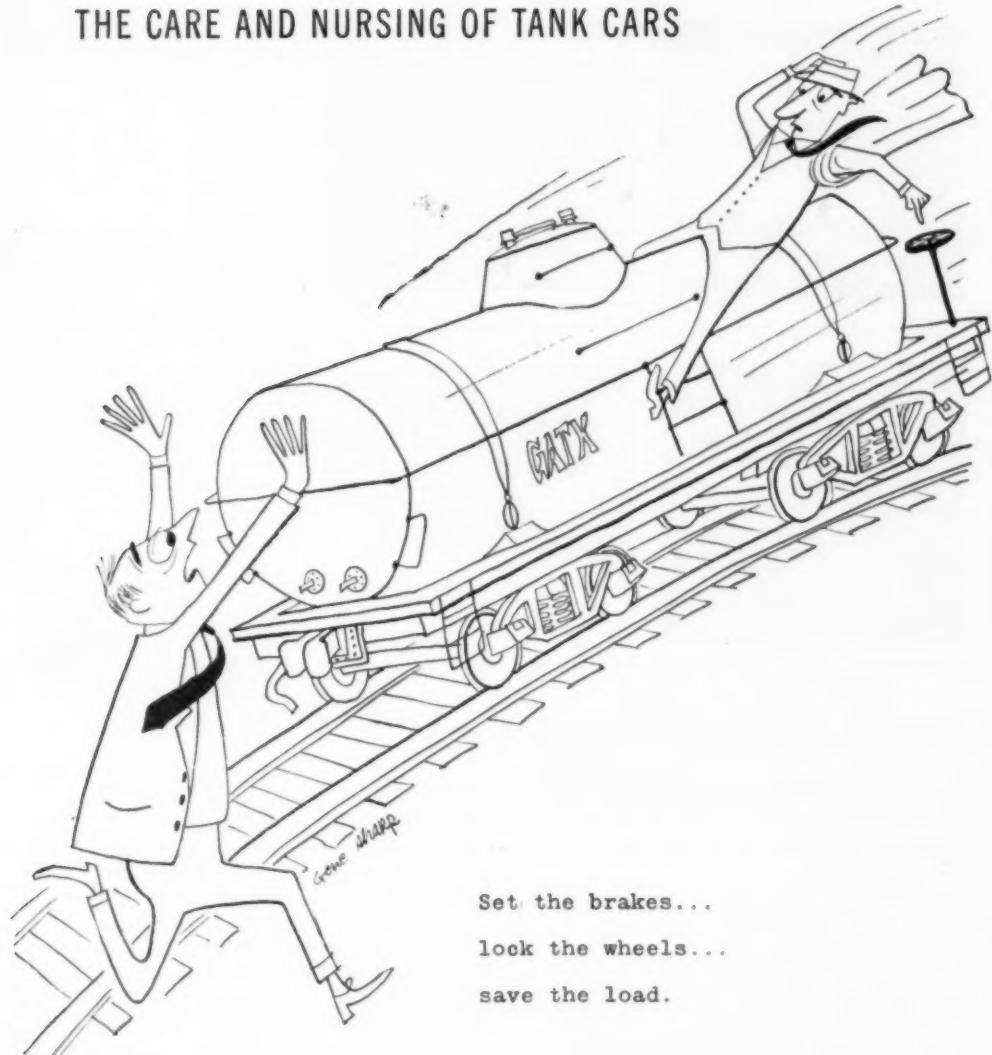
Filing Cabinet For Large Charts, Drawings

The Draw-In-Dex is a recently announced filing cabinet which accommodates large drawings, charts, maps and blueprints. Each cabinet can hold up to 1,000 prints, hanging smoothly without creases, wrinkles or curled edges.

All prints are immediately accessible, and any print can be removed without disturbing the others. Drawings are attached to manila hangers and suspended from horizontal rods.

The cabinet is $\frac{4}{5}$ ft. high by $2\frac{1}{2}$ ft. wide by 20 in. deep. Made of 16 and 18-gage steel, it can be had in gray, green or brown.—Empire Development Co., 15 Park Row, New York 38, N. Y.

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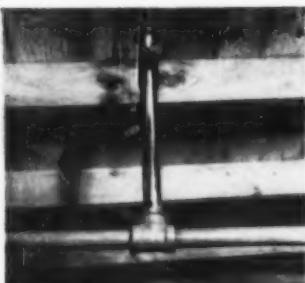


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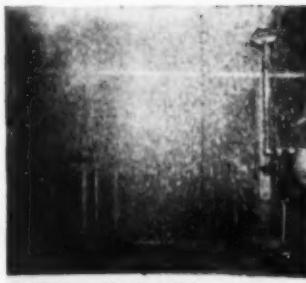
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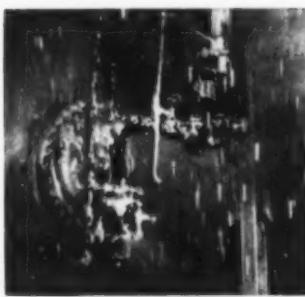
NEW SAFETY EQUIPMENT



SPRINKLER for foam discharge.



DISCHARGE resembles snowstorm.



FOAM clings to vertical surfaces.



WATER does not disturb foam blanket.

Sprinklers Deliver Air Foam

New Solvay installation combines the advantages of automatic sprinklers, water spray and foam. Less water is required, lowering the investment in pumps and storage.

Air foam, a substance used extensively in aircraft and shipboard fire fighting during the last war, is just now coming into its own for protection of industrial plants. One such case is the new specially designed installation at the Syracuse plant of Solvay Process Div., Allied Chemical & Dye Corp. This system is located in the chlorination and distillation buildings where benzene and benzene derivatives are processed.

The idea was to integrate a foam injection system with deluge sprinkler equipment. Foam discharge outlets are located in accordance with Underwriters' requirements for automatic sprinklers. Water pressure is maintained at 50 psi., rather than the normal 7 to 8 psi., but much less water is consumed. This factor reduced the large investment Solvay was facing in additional water pumps and storage facilities.

Whenever the system goes into operation, 6 percent foam stabilizer is accurately and automatically fed into the flow of water through precision engineered orifices; this mixture is aerated as it passes through the foam spray sprinklers. The foam discharge resembles a dense, heavy snowstorm.

Foam is discharged at a rate of 2 gpm. per sq. ft., equivalent to a floor depth of approximately 3 in. per min. Sufficient stabilizer is available to operate normally for 10 min. At the end of this period, water spray will continue to discharge from the outlets for as long as desired.

EFFECTIVENESS OF FOAM

Air foam extinguishes fires by smothering them—cutting off air supply—rather than by cooling flammables below ignition temperature. It consists of closely knit air-filled

bubbles, differing from chemical foam in that the latter consists of bubbles of carbon dioxide. Air foam is the more recent of the two.

It is claimed that continued discharge of water spray from the sprinklers does not impair the quality of previously discharged air foam, whereas water more readily breaks down chemical foam.

Air foam has a decided advantage over water, it is said, in fighting certain fires of highly flammable liquids, where low flash points resist extinguishment by cooling. It is also effective where low specific gravities cause burning liquids to float on water, resulting in possible spread of fire or flashbacks. Since it will adhere to vertical surfaces and ceilings it is valuable in protecting equipment or structures surrounding fire hazards.—"Automatic" Sprinkler Corp. of America, P.O. Box 360, Youngstown, Ohio.



Face Shield With Spark Protector

A new face shield, known as the Halo, features an all-green plastic spark protector, affording wide-angle vision, yet still eliminating glare from overhead lighting. Another new development locks the visor in the up position or the working position, thus eliminating the possibility of the wearer's adjusting the visor so that it does not afford proper protection.

The Halo is available in three styles of headgear with clear or green visors and a special acid-resistant visor for use around acids and other chemicals. With the headgear made of cellulose acetate-butylate, the face shield weighs less than 6 oz. It is said to combine rugged construction with attractive appearance.—United States Safety Service Co., 1215 McGee St., Kansas City 6, Mo.

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or liquid, up to 300°F.

Your best valves for handling chlorine are those made expressly for this service. It's too tough for ordinary equipment.

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You'll operate more safely, efficiently, and dependably with these Crane Chlorine Valves. Their rugged forged steel construction gives you protection against internal and external shock. You'll have freedom from bonnet joint leakage with their strong Crane bolted design.

Effective Corrosion Resistance

You'll be equipped for highest resistance to corrosion with the Hastelloy "C" disc and seat rings, and the Monel stem. A corrugated soft Monel gasket prevents corrosion and leakage at the bonnet joint.

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The many refinements of Crane Chlorine Valves assure not only more efficient chlorine control, but important savings on valve maintenance and replacement costs. Get the complete facts in Circular AD-1608. Write or ask your Crane Representative for a copy.

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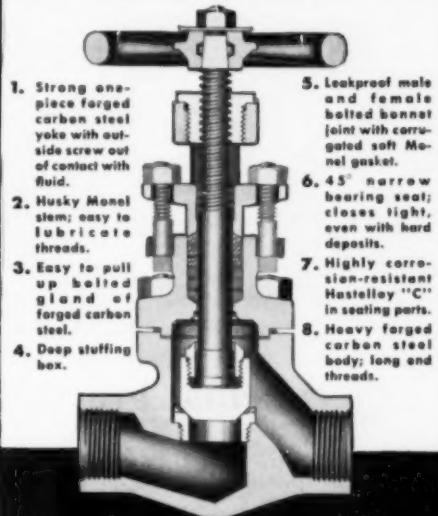
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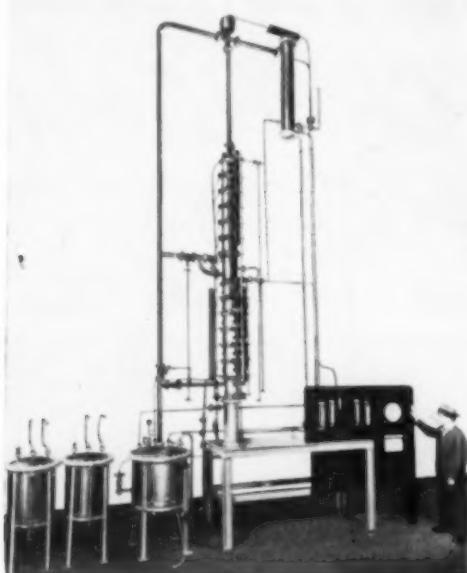


No. 1645
Angle
Sizes $\frac{1}{2}$ to 2 in.



No. 1644 Globe
Sizes $\frac{1}{2}$ to 2 in.

NEW PROCESSING EQUIPMENT



Experimental Fractionator

Designed for undergraduate instruction, this versatile and flexible unit can double for many types of engineering and process development studies.

The distillation unit shown here was designed in collaboration with the department of chemical engineering of Princeton University for use in an undergraduate unit operations laboratory. Rated at 30 in. vacuum to 40 psi. pressure, it is claimed to be the most complete design ever offered in equipment of this type.

The 5-in. dia. fractionating column is divided into two sections. It is connected in such a manner that you can operate with only the lower section, if desired. All plates are removable and have three 2-in. bubble caps and one 1-in. adjustable down-comer. Additional plates can be added at any time.

Each plate is provided with a remotely operated valve for withdrawing liquid samples. A single switch operates all these valves, allowing samples to be drawn simultaneously and collected separately in sample cups on the control board.

The 60-gal. kettle is equipped with a steam coil and sparge ring. The 20-

gal. receiving tanks are designed for scale mounting with flexible metallic connecting tubes. Kettle and receivers are complete with inlets, drains and gage glasses.

All inaccessible bypass valves, as well as valves for selecting the feed plate, are either remotely operated from the control board or reached from the floor by extension rods.

The degree of instrumentation leaves little to be desired. In addition to feed, reflux and distillate rotameters, there is a six-point recording thermometer for the six lower plates, specific gravity indicators for top and bottom products, column differential pressure manometer, and recording controller for steam pressure to the kettle coil.

Made of copper, a unit like this costs about \$10,000; a somewhat simpler unit, omitting the instruments, can be furnished for about \$7,000.—Brighton Copper Works, Inc., 2144 Colerain Ave., Cincinnati 14, Ohio.

Jaw Crusher In Larger Size

Type H Jaw crusher is now available in a 10 by 20-in. size. Rated capacity runs from 6 tons per hr. of 1-in. product to 52 tons per hr. of 3-in. product. A 30-hp. motor is required. Approximate shipping weight is 6,200 lb.—Denver Equipment Co., 1400 Seventeenth St., Denver, Colo.

Porous Stainless Sheet With Smooth Surface

A new porous stainless sheet with a smooth surface is expected to widen the application of porous metallic filters, particularly where ready release of collected solids is required. Applications might include rotary vacuum filters cleaned by blowback, vacuum plate filters, fluid catalyst filters, etc.

The new material has much higher mechanical properties than porous sheet previously available. Shear strength, for example, is about 60,000 psi. High-pressure filters can thus be constructed with less metal.

Flow capacities range downward from 200 cfm. of air per sq. ft. at 10 psi. differential pressure, or from 20 gpm. of water per sq. ft. at the same differential. Pore diameters range from 20 microns down.

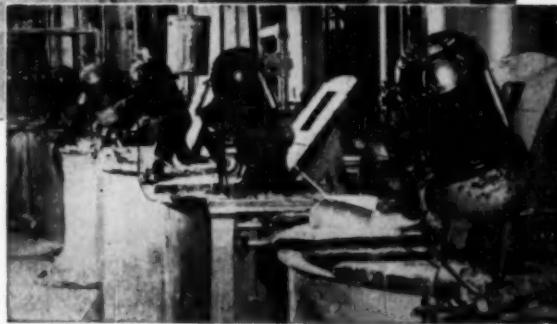
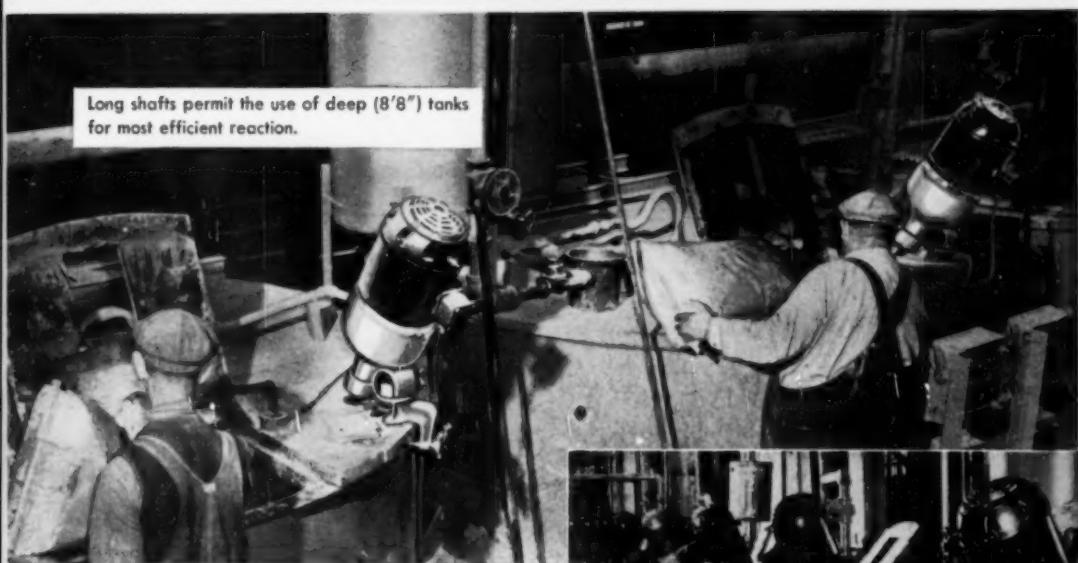
Sheets will be stocked in Type 304 stainless steel, but are available also in Types 309, 316 and 347, and in other alloys, such as Monel and Stellite L-605. A complete line of filter assemblies now uses the new smooth-surface material.—Micro Metallic Corp., 30 Sea Cliff Ave., Glen Cove, N. Y.



Portable Mixer With Flexible Drive

Removal of the driving motor from its conventional position at the top end of the propeller shaft makes this new mixer, called the Pie-Flex, espe-

Long shafts permit the use of deep (8'8") tanks for most efficient reaction.



These "Lightnin Mixers" Have Been Doing the Job Right for Over 10 Years!

"Our LIGHTNIN Mixers were installed in 1941. They've been doing an excellent job ever since," says Dr. J. M. Perri, plant superintendent, National Foam System, Inc., West Chester, Pa. National Foam uses a battery of eight 1-HP LIGHTNIN Mixers in the manufacture of its AER-O-FOAM fire-fighting compound.

Dr. Perri goes on to say, "LIGHTNIN Mixers have proved easy to install. They have been practically free of mechanical troubles, and their long shafts permit us to use deep reaction tanks for most efficient processing."

If your requirements call for fluid agitation, consult MIXCO. We have the research and engineering facilities to accurately predict processing results—and we'll absolutely guarantee those results with LIGHTNIN Mixers. Write us about your requirements.

LIGHTNIN case history

OPERATION:	Reaction of protein product (soya) with lime and water for hydration.
TANK:	3300 gal. stainless steel tank, 96" diameter x 104" straight side height, open top and dish bottom.
HEATING:	Two steam coils to heat batch to 200°F.
REACTION TIME:	One hour (approx.)
MIXING:	One 1-HP LIGHTNIN Portable Mixer.
MIXER PERFORMANCE:	HIGHLY SATISFACTORY. User has obtained excellent results from these mixers for more than 10 years.

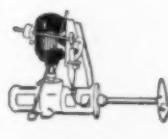
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cially light and portable. The motor is coupled to the propeller shaft by a flexible drive shaft especially designed for agitator service.

The propeller shaft is supported by two widely spaced ball bearings in a cast aluminum alloy body. It can be mounted at any angle; adjustment is facilitated by a lever-operated positioning device.

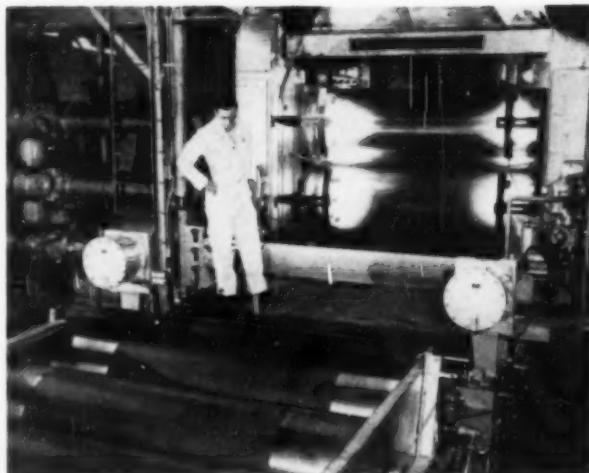
No special motor is required—any standard horizontal motor can be used. The motor can be mounted in any suitable location. For instance, in the case of hazardous operations, you might even mount the motor out of the hazardous area by running the flexible drive shaft through a hole in the wall to another room.—*Process Industries Engineers, Inc., Pittsburgh, Pa.*

Dust Filter Cleans Without Flexing

The Simon dust filter, used abroad for many years, is being redesigned to U.S. requirements. This filter uses fabric sleeves and a hopper bottom, much like conventional dust filters.

Its novel feature, however, is its shaking mechanism. When the cloth sleeve is shaken, it does so without flexing. An entire frame carrying a group of eight sleeves is lifted and falls with an impact which dislodges the dust, meanwhile maintaining the sleeve taut and smooth.

Units are available with ratings up to 13,200 cfm.—Entoleter Div., Safety Car Heating & Lighting Co., Inc., P. O. Box 904, New Haven 4, Conn.



PLASTICS CALENDER PRODUCES 120 MILES PER DAY

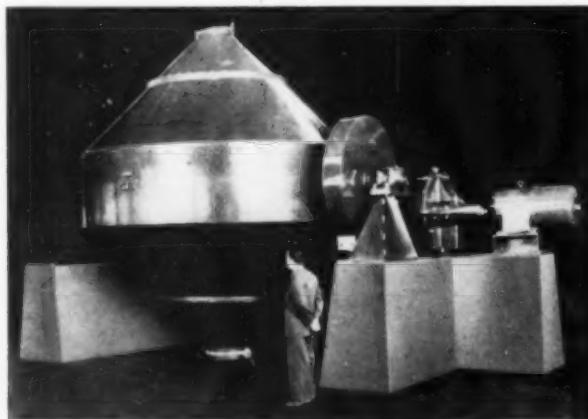
Recently installed at Akron by Goodyear, this calender is claimed to be the fastest ever built for producing plastic film. It is designed to produce more than 120 miles per day of 6-ft. wide vinyl film in thicknesses up to 20 mils. Each of the four rolls is 92 in. wide and 32 in. in diameter, weighing 25,000 lb. apiece.—Adamson-United Co., Akron, Ohio.

Oxygen Generators Save to 50 Percent

Users of high-purity oxygen in quantity can now make their own at savings up to 50 percent, according to a recent announcement. Semi-portable generators, soon to be available in sizes from $\frac{1}{2}$ to 12 tons per day, will be able to produce 99.5-per-

cent oxygen at an operating cost of 5 to 10 c. per 100 cu. ft., it is claimed. Savings to the consumer will come mainly from eliminating oxygen transportation.

Heart of the new generator is a series of automatic reversing heat exchangers which eliminate the expense of chemical purification of the air. Design was developed with the assistance of Prof. S. C. Collins of MIT.—Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa.



DRY BLENDER HANDLES BOXCAR BATCHES

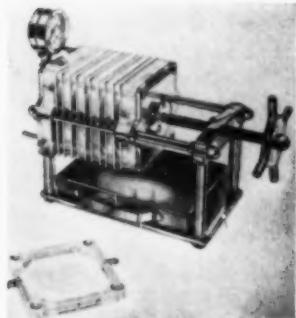
Believed to be the largest ever built, this conical dry blender, 13 ft. in diameter, can hold the entire contents of a railroad car. It was built recently for a manufacturer whose process required handling large volumes in order to maintain product uniformity.—Patterson Foundry & Machine Co., E. Liverpool, Ohio.

Screen-Heating Unit Avoids Blinding

Thermo-Deck heating unit is a new device which permits you to screen moist, fine materials without blinding of the screen openings. Electric current carried by the screen wire from one side to the other heats the solids enough to dry them and prevent them from building up on the screen.

Small air-cooled dry transformers especially designed to operate in dusty atmospheres are furnished with the Thermo-Deck. These transformers require no special dust-proof enclosures and can be conveniently located on stationary supports adjacent to the screen or suspended above the screen. Flexible copper leads are used between the transformers and the bus bars attached to the vibrating screen frame. Low voltages are used for ob-

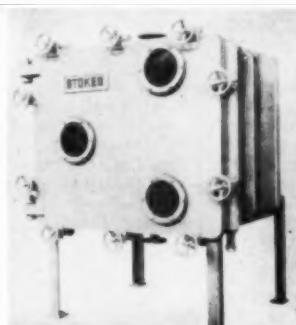
vious safety reasons.—Allis-Chalmers Mfg. Co., 1147 S. 70th St., Milwaukee, Wis.



**Laboratory Filter
Permits Visual Study**

Lucite construction of this new laboratory filter permits visual study of the filtration process: It is made in two sizes—4 in. square with approximate filtration area of 11 sq. in. per sheet, and 8 in. square with approximate area of 52 sq. in. per sheet. It uses asbestos filter sheets in various grades of retentivity.

Where desired, stainless steel parts can be substituted for Lucite. This is necessary if liquid temperature is above 120 deg. F.—Ertel Engineering Corp., Kingston 11, N. Y.



**Vacuum Shelf Dryer
Permits Easy Observation**

Construction changes in this vacuum shelf dryer provide, among other advantages, easier observation of the interior. Sight glasses are larger, and a swivel spotlight attached to the door can be quickly and easily moved to any one of the ports.

The door has been changed from cast iron to steel. This makes it stronger, free from pitholes and leaks, and easy to coat with special materials.—F. J. Stokes Machine Co., 5500 Tabor Rd., Philadelphia 20, Pa.



Rubber Lined Equipment

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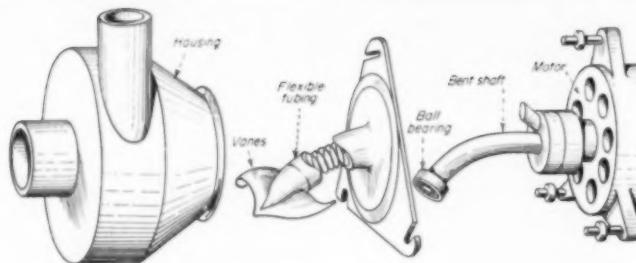
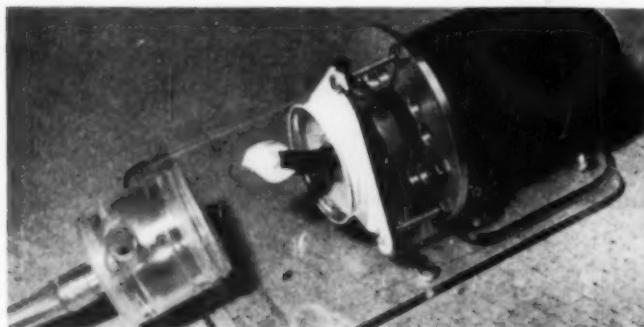
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NEW FLUIDS HANDLING EQUIPMENT



Bent Shaft Drives New Pump

Packless and hermetically sealed, the Vibro-Pump handles slurries with ease. It will even pump up to 20 percent vapor without vapor lock, it is claimed.

First introduced last fall via television's Big Idea program, the Vibro-Pump has already attracted a great deal of attention from many quarters. And a pump which eliminates packing, can handle mixed liquid and vapor, pumps abrasive slurries, and can be easily sterilized ought to attract attention.

DIFFICULT TO DEFINE

The Vibro-Pump employs a principle of operation which resembles nothing else in common use. Location of suction and discharge ports suggests centrifugal action, yet the volute shape of a centrifugal housing is missing. The pushing action of the vanes suggests several types of positive displacement pump, yet the side clearances between vane and housing are very liberal, and the capacity varies inversely with discharge pressure.

Business end of the pump is an impeller provided with two or more wave-shaped vanes. The more vanes, the greater the discharge pressure.

Vanes are fixed on the free end of a flexible rubber tube which is belled at the opposite end to form a flat circle.

The impeller is driven by a curved shaft rotating within the rubber tube but in contact with the tube only through a ball bearing at the free end. As the shaft rotates, its free end describes a circular orbit. The impeller, fixed in position at its flat end, follows the orbit with its free, vane-equipped end.

ORBITAL MOTION

The impeller describes an orbit about the center of the motor, therefore, but does not rotate around its own center of gravity. Its path is something like that followed by the left hand of an automobile driver when he signals the driver behind to come around him.

The Vibro-Pump was invented by William Gemeinhardt, a former flier and research engineer in the Hungarian Air Force. When he first came

to this country in 1949 he was employed as a research engineer at New York University on an Air Force project. He is now working on his pump in the chemical engineering laboratories of Drexel Institute of Technology, Philadelphia.

Although the new pump is not yet in commercial production, a number of manufacturers have expressed interest. Negotiations are under way for the manufacture in large quantities of a small size as a component in a popular make of household dish-washing machine. A well known builder of process evaporators is looking into the Vibro-Pump as a means of pumping crystal slurries without deterioration of the crystals.

Test results are available for a model which handles 30 gpm. at free delivery and develops a cut-off head of 18 psi. of water. Arrangements are being made to build a pump with a capacity of 150 gpm.—*Bennett Productions, 1507 Walnut St., Philadelphia 2, Pa.*

Control Valves For Extreme Services

Two new control valves, Models 1570 and 1580, are said to handle a wide variety of materials at extremes of temperature and pressure. These include liquid nitrogen at -325 deg. F. and 3,000 psi., fuming nitric acid at room temperature and superheated steam up to 1,000 deg. F.

These single-seated valves feature an external self-balancing arrangement which provides a balanced valve effect in operation. This provides ease of operation at extreme pressure differentials while still retaining tight shutoff.—*Anvin Co., 3500 Union Pacific Ave., Los Angeles 23, Cal.*

Glass Pipe Up to 18 In. Diameter

What is claimed to be the world's largest glass pipe with flanged ends suitable for bolting is now in quantity production. This pipe, 18 in. in diameter, will probably find its way into equipment like heat exchangers and absorption towers more often than for straight fluid transport, at least for the near future.

These 18-in. pipes are made by joining a flange pressing to a length of molded tubing. The initial problem was the manufacture of a pressing of this diameter and thickness. Other problems which had to be solved were the lampworking of these press-

facts you may want to know about—

Magnesium Trisilicate

For most
American
Producer

Dependably
Uniform

Forms
Available

Important
Properties

Companion
Products

Mallinckrodt, one of the first American producers of pharmaceutical grades of magnesium trisilicate, began manufacturing this valuable antacid in 1937 and is today among the foremost domestic producers.

Of special value to pharmaceutical manufacturers is the high degree of lot-to-lot uniformity of Mallinckrodt magnesium trisilicate, not only in chemical composition but also in moisture content, particle size distribution, and bulk. Mallinckrodt magnesium trisilicate fully meets U.S.P. requirements.

To fit both tabletting and suspension needs Mallinckrodt magnesium trisilicate is supplied in the following forms:

Magnesium Trisilicate U.S.P. Powder

Magnesium Trisilicate U.S.P. Bulky

Magnesium Trisilicate U.S.P. Super Bulky

Important Properties—Typical Values

	Powder	Bulky	Super Bulky
Bulk—Approx. fl. oz./lb.	45	75	130
Approx. Particle Size Distribution*			
less than 5 microns	15%	50%	65%
5-10 microns	10%	30%	15%
10-20 microns	35%	10%	15%
20-40 microns	40%	10%	5%
Adsorptive power— mg. methylene blue/gram	not less than 100	not less than 200	about 150
Acid consuming capacity— cc. N/10 HCl/gram	140-160	140-160	140-160

For alkaline mixtures containing magnesium trisilicate, Mallinckrodt also supplies top-quality companion products such as Magnesium Carbonate U.S.P., Calcium Carbonate U.S.P. and Bismuth Subcarbonate U.S.P.

Samples and prices will be supplied on request. For technical information write for Magnesium Trisilicate Data Unit X-312.

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FOR INDUSTRY • SINCE 1867 •



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Quality . . . Filtration

SPARKLER FILTERS

High quality, sharp filtration has always been one of the prime features of Sparkler Filters. Many times Sparkler Filters have been chosen by experienced filtration engineers for this one point of superiority.

Here's why

...any kind of filter paper, cloth, or screens, and any filter media can be used to obtain maximum efficiency. . . . no breakage of the filtering surface even with intermittent operation as pressure is not required to hold cake in position on the horizontal plates.

...flow is always with gravity, down through the cake in a natural direction. The cake will not break, crack or slip because it is supported in a horizontal position and is not subject to tensile or distortive strain.

When you are looking for fine quality filtering, Sparkler Filters will do the job.

For personal engineering service write Mr. Eric Anderson.

Sparkler
representatives
in all principal
cities.

SPARKLER MANUFACTURING COMPANY

Mundelein, Ill.

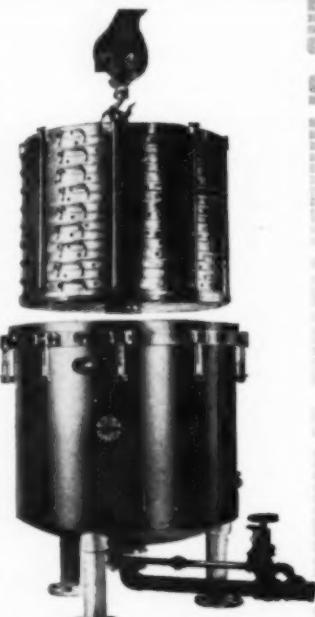
Sparkler International, Ltd.

Barngraacht 560, Amsterdam, Holland

Sparkler Western Hemisphere Corp.

Mundelein, Ill., U.S.A.

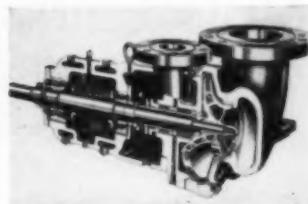
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Pharmaceutical,
Food and
Petroleum
Industries
for over
a quarter of a
century.



SPARKLER FILTERS·SPARKLER FILTERS

EQUIPMENT NEWS, cont. . .

ings to the cylinders and fabrication into other equipment units. There is no particular problem in application of the large pipe to chemical processing aside from the usual limitations of glass construction.—Quickfit & Quartz Ltd., 1, Albemarle St., Piccadilly, London, W. 1, England.



**Process Pump
Handles Hot Liquids**

Suitable for liquids up to 850 deg. F., the new Type PR process pump provides capacities up to 1,000 gpm. and heads up to 625 ft. Here are some of the important construction features noted by the manufacturer:

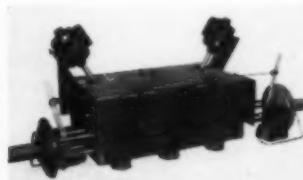
1. Centerline-mount design maintains pump alignment at any temperature.

2. Impeller has been designed for minimum NPSH, permitting operation with suction vessels at lower levels without flashing of liquid within the pump.

3. Positive support beneath the pump case prevents strains from being imposed on the rotating parts, adding to bearing and packing life.

4. All internal joints have been eliminated where differential pressure across them would cause leakage or corrosion.

Two models are offered, one with top suction and top discharge, the other with end suction and top discharge. Mechanical shaft seal can be supplied when desired.—Peerless Pump Div., Food Machinery & Chemical Corp., Los Angeles 31, Calif.



**Proportioning Weir Tank
For Splitting Liquid Flows**

A new proportioning weir tank which can be used with either solu-

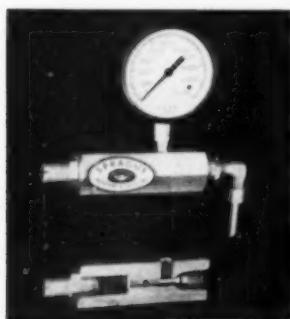
tions or suspensions is provided with means for instantly adjusting the position of the flow splitter.

Primary function of the device is to divide an incoming fluid flow into two or more outgoing streams. Liquid coming into the receiving compartment passes beneath a baffle to a stilling compartment, then overflows a weir and empties into the distribution chamber, first spilling over the flow splitter, which apportions it to the various divisions of the distribution chamber.

The flow splitter is manually or mechanically adjustable to process requirements by a convenient lever arrangement and is graduated in percent of flow. The tank in the illustration has a double weir with pneumatic positioners.

By providing the tank with sparger pipes or motor-driven agitators, you can handle slurries or suspensions.

The standard tank is 24 by 20 by 20 in., fabricated of stainless steel with a cast bronze weir. Tanks of other sizes, as well as tanks fabricated of mild steel or rubber-lined steel, are available.—Omega Machine Co., P. O. Box 1342, Providence 1, R. I.



Shut-Off Valve Protects Pressure Gage

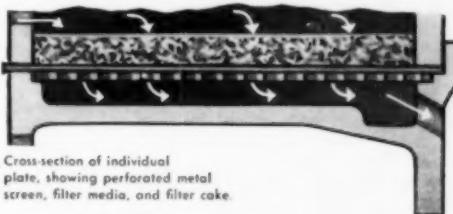
Whenever system pressure goes beyond the operating limits of a pressure gage, this new shut-off valve automatically cuts out the gage from the system, thus protecting it from damage. It automatically reopens the gage to the system when the pressure is again within range.

A compression spring controls the shut-off point. Minor changes or adjustments may be made by adjusting the screw positioned at one end of the device. Major changes are made by simply replacing the compression spring. Pressure ratings available range from 30 to 5,000 psi.

Piping connections are $\frac{1}{2}$ in. at the system end and $\frac{1}{4}$ in. at the gage end.—Sprague Engineering & Sales Corp., Gardena, Calif.

SPARKLER FILTERS·SPARKLER FILTERS·SPARKLER FILTERS·SPARKLER FILTERS·SPARKLER FILTERS·SPARKLER FILTERS

FREE DRAINAGE IN SPARKLER FILTERS



Cross-section of individual plate, showing perforated metal screen, filter media, and filter cake.

High flow rates cannot be assured by large filtering surfaces *alone*. Another important factor is provision for drain-off space capable of carrying away all liquid that the surfaces can handle.

In Sparkler filters, the Free Drainage design of Sparkler horizontal plates eliminates one of the primary causes of liquid flow frictions — providing a clear, unobstructed channel through which filtered liquid can drain rapidly and more completely. To accomplish this, Sparkler uses a series of smooth, widely spaced buttons as the means of supporting the filtering surface, thereby ending the need for heavy wire mesh or other types of media support that have high coefficients of friction.

Features such as these, hidden from the eye, are typical of standard Sparkler construction, and are responsible for Sparkler superiority. Coupled with highest quality, operational economy, and simplified maintenance, free drainage makes Sparkler filters ideal for every filtering need and makes them particularly well adapted to the filtration of viscous liquids.

Available in a complete range of sizes and materials.

Write for your copy of our new catalog.



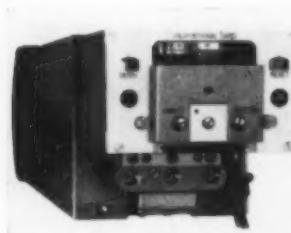
SPARKLER MANUFACTURING COMPANY
Mundelein, Illinois

Sparkler International, Ltd.
Berengraaf 546, Amsterdam, Holland

Sparkler Western Hemisphere Corp.
Mundelein, IL, U.S.A.

SPARKLER FILTERS·SPARKLER FILTERS

NEW INSTRUMENTS & CONTROLS



Force-Balance Controller Uses a Floating Disk

Acting both as a force-balance detector and as the flapper of a conventional flapper-nozzle system is a floating disk, the novel functional part of a new force-balance controller.

The disk rests in an essentially horizontal position on four bellows spaced around its circumference. There is one bellows each for measurement, set, proportional and reset.

Any change in pressure in the measurement (or set) bellows slightly raises or lowers that side of the disk, causing a change in nozzle pressure which operates a relay to increase or decrease the output (valve) pressure. This pressure, acting on the proportional bellows, changes enough to re-establish a balance of the forces on the disk. The amount of output pressure change is thus proportional to measurement (or set) pressure change.

If there is a sustained differential between set and measurement, a sustained difference between proportional and reset bellows pressures will result. But air will flow from one to the other, causing the disk to throttle the relay and change output pressure continuously to maintain this difference. This is reset control action.

The restriction between proportional and reset bellows is adjustable, and hence reset rate is proportional to both the amount of the restriction and to the deviation of measurement from set point.

The illustration shows this new controller, known as Model 58P4, mounted integrally on the rear of a Consotrol recorder.—The Foxboro Co., Foxboro, Mass.

Controlling Calorimeter For Fuel Gases

The Sigma-Kent controlling calorimeter is a new instrument developed for better control of the calorific value of manufactured fuel gases. It will help reduce fluctuations in calorific value where gas storage capacity is limited.

Basic parts are a calorimeter and a

pneumatic control unit. The calorimeter is made up of a gas flow regulator, measuring device and recording mechanism. Function of the regulator is to supply gas to the measuring device at a rate which would be constant if reduced to standard temperature and pressure. The regulator also provides automatic compensation for changes in gas specific gravity and ambient temperature.

The gas passes from the regulator to a burner in the measuring device. The burner is at the bottom of a vertical steel tube through which the products of combustion pass to atmosphere. This tube is contained within a second steel tube concentrically mounted; the lower ends of both tubes are rigidly joined together, and the upper end of the outer tube is fixed to the instrument case.

A bar attached to the upper end of the inner tube transmits the relative expansion or contraction of the inner tube to the recording linkage. This relative movement is a direct measure of the calorific value of the gas being burned.—George Kent Ltd., Luton, Bedfordshire, England.



Pressure Recorder Is Compact, Precise

The Type 3-B Minicorder, measuring only $\frac{5}{8}$ by $\frac{5}{8}$ by 24 in., provides a continuous chart record with a precision comparable to larger conventional instruments. The latest addition to the manufacturer's line of Minicorders, this one is designed for pressure ranges as low as 0 to 10 in. of water.

Measuring elements are enclosed in an all-metal case, completely rubber-gasketed for protection from dust, moisture and weather. These elements consist of a series of brass bellows suitable for liquids and gases not corrosive to brass; for certain ranges stainless steel bellows may be substituted. A 1-in. male bottom connection makes the Minicorder interchangeable with most dial gages.—The Dickson Co., 7420 Woodlawn Ave., Chicago 19, Ill.



Program Controllers For Time and Temperature

Two new controllers have been developed for programming time-temperature schedules for process operations.

The electronically operated circular-chart instrument (illustrated) accomplishes this function through a mechanism which consists basically of a rotating plastic cam, cut to the desired time-temperature pattern, and a cam follower which operates to vary the position of the set-point index in accordance with the contour of the cam.

The transparent cam, which is printed with the same graduations as are on the recording chart, is driven by a separate motor and gear train, providing a variety of cam rotation speeds. A clutch enables quick setting of the cam to the precise starting point or manual adjustment of cam position during operation.

The other new instrument is an electronic strip chart controller, equipped with a motor-driven set-point index. It is designed particularly for programming of heat-treating operations.—Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.

Venturi Ball Valve Now Cylinder-Operated

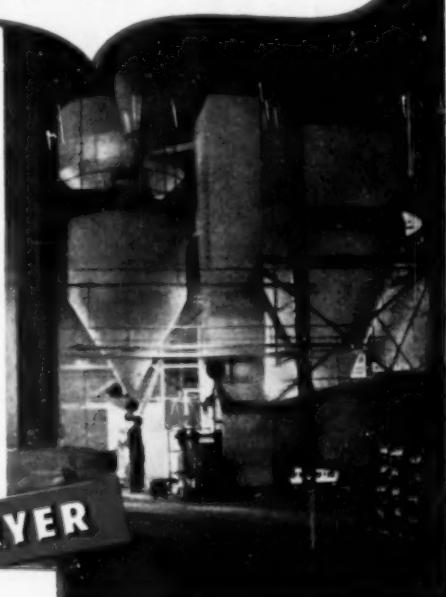
The venturi ball valve, featuring a precision ground ball actuated by the Paul venturi principle, is now available in combination with pneumatic cylinder operators. This combination is said to handle many difficult control problems involving corrosive fluids, abrasive materials, high temperatures and pressures.

Since the cylinder operator includes a positioning mechanism as a component part, the new assembly can be used in conjunction with standard pneumatic control instruments for automatic control or with manual load-

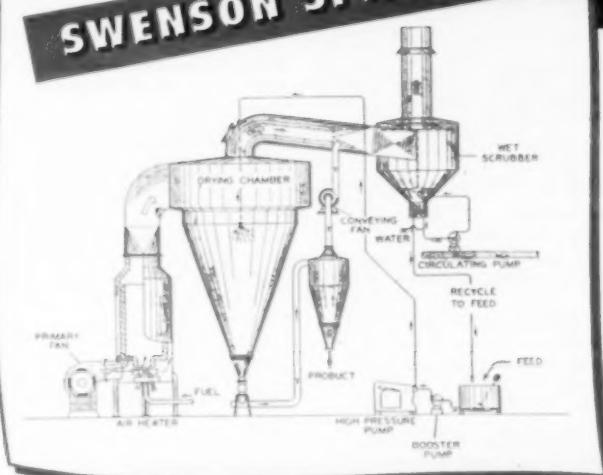
for DRYING HEAVY CHEMICALS at Low Cost

Here is high-capacity spray-drying equipment that is especially suitable for handling heavy chemicals. It is direct fired, uses either oil or gas as fuel, and gives amazingly low-cost operation.

It is but one of many applications of Swenson* Spray Dryers in the process industries. We will welcome an opportunity to assist you in adapting this equipment to your particular drying problems. Have you sent for our descriptive Bulletin D-105?



SWENSON SPRAY DRYER



Direct-fired spray drying may be used for such materials as:

Silica gel

Kaolin clay

Manganese sulfate

Calcium carbonate

Chrome sulfate

Sodium phosphate

Flow sheet shows typical spray-dryer installation for handling heavy chemicals.

*Reg. U. S. Pat. Off.



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NEW

STEAM METER



BUILDERS 1952 MODEL SHUNFLO METER

- For STEAM, AIR or GAS

Gives you answers
to steam consumption
in POUNDS,
not GUESSES.

FEATURES

New streamline cooling and damping chamber

range, within $\pm 2\%$ of actual flow

Improved durability and ruggedness for longer service

"Open upper limit", temporary overload capacity of 150%

No stuffing box to leak or cause friction

Self-contained and self-operated

High accuracy over wide

As easy to install as a valve or fitting

Builders Shunflo Steam Meters are available in two styles: Model SMKS for 2" to 14" lines — Model SMDH for 1" and 1½" lines. Send for descriptive Bulletins 400-F1 and 400-F2. Builders-Providence, Inc. (Division of Builders Iron Foundry), 369 Harris Ave., Providence 1, Rhode Island.

BUILDERS *J* PROVIDENCE
Instruments

Instruments for recording, indicating, and controlling flow, liquid level, pressure, and weight. Chlorinators — chlorine gas feeders.

EQUIPMENT NEWS, cont. . .

ing stations for remote manual positioning.

The streamlined venturi passage and smooth-surfaced ball provide a non-turbulent flow pattern in the valve. Inherently a single-seated valve, the Paul principle reduces unbalanced forces to low values so that the advantage of tight shut-off may be obtained without sacrificing control sensitivity, it is claimed. A straight-line relationship between valve lift and flow make the Paul valve well suited for throttling control service.

The new assembly is available in valve sizes to 8 in. and in a wide variety of body materials.—Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.



Purge Rate Regulator
Ignores Pressure Changes

Type 6000 constant differential relay is a recently developed device for maintaining constant purge rates regardless of changes in supply pressure or downstream pressure. It is used to supply air to the dip tubes of level or specific gravity indicators, or for any constant purge where the downstream pressure may vary, such as in transmitter lines from field instruments to central panels.

The relay is completely automatic and self-contained. Its principle of operation involves the maintenance of a constant differential pressure across an internal diaphragm.—Instruments, Inc., 122 No. Madison, Tulsa 6, Okla.

Oxygen Indicator Is Simpler to Operate

A new and improved model of oxygen indicator, the Type C-2, has been developed in an effort to simplify the operation and maintenance over the older Type C. The new instrument has just three points which need attention: the carbon electrode, which must be replaced periodically; the detector cell, which requires an ounce

or two of Oxylite about every two weeks; and a small dry cell which must be replaced every week. On the control panel there are now only zero, calibration, and drift control rheostats and an on-off switch.

The unit can be used to measure the oxygen content of fuel gases, flue gases, inert atmospheres, etc. In operation, the sample to be analyzed passes through a hollow carbon electrode in a detector cell. Hydrogen evolved at the electrode causes polarization of the cell, which manifests itself in a decrease of the generated voltage and current. Oxygen from the sample diffuses through the wall of the electrode and combines with the hydrogen, thus producing a depolarizing effect. Consequently, the more oxygen the sample contains, the higher is the electric current generated by the cell.—Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8, Pa.



**Temperature Controller
Is Time-Proportioning**

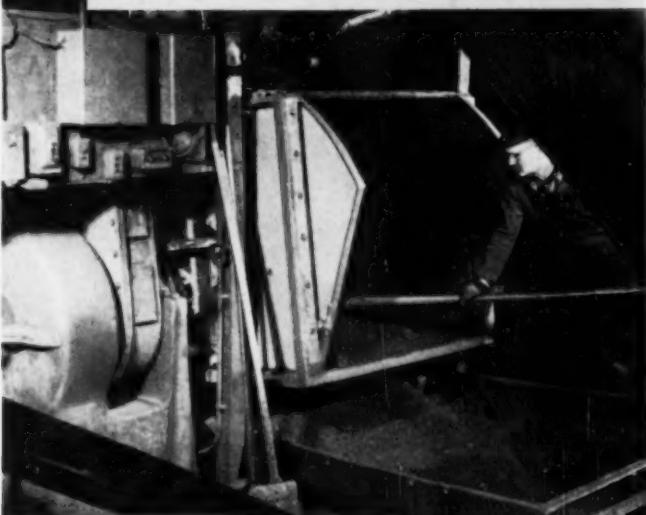
The new pulse Pyr-O-Vane controller is designed to provide close temperature control of such equipment as furnaces and ovens by means of a proportional on-time relay within its proportional band.

The time-proportioning control unit consists of an oscillator, amplifier and relay in a circuit similar to that of other Pyr-O-Vane controllers. In addition, there is a gear train, synchronous motor, eccentric aluminum vane and a set of oscillator coils.

The controller has a periodic relay action determined by the speed of rotation of the eccentric vane. The face of the vane is calibrated in percent proportional band and the setting of the band may be easily changed by loosening two small screws and rotating the vane on its hub. The length of the actuation period is constant, but can be changed by replacing a gear in the gear train with one of the six change gears which are provided.

The eccentric vane rotates through a set of oscillator coils. During each rotation it penetrates the coils sufficiently to stop oscillation, de-energizing the relay and de-energizing the

OVER 10 YEARS AND 260 MILLION POUNDS AGO...



General Dry Batteries, Inc., installed Readco Double-Arm Mixers in its Dubuque, Iowa and Cleveland, Ohio Plants to mix depolarizer materials for its complete line of Radio, Flashlight, and Hearing Aid batteries. These mixers have been in continual use, handling capacity loads of this abrasive, highly corrosive compound without a breakdown.

Readco Mixers are designed to do a specific job. They do it well.

READ STANDARD

CORPORATION

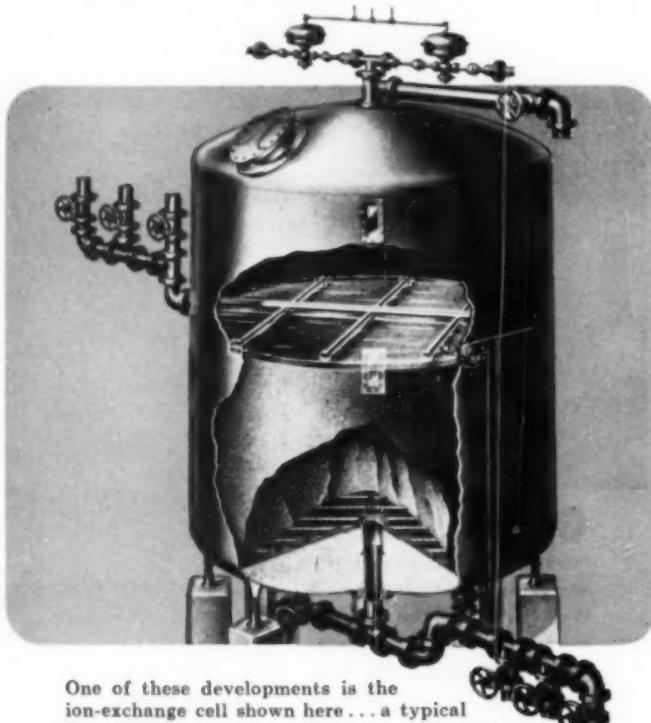
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**make Dorr's
experience a part of your plan—**

Equipment for the increasing use of ion-exchange techniques in the chemical process industries is being continually developed and improved by Dorr engineers. Whenever you are thinking of ion-exchange make use of our experience . . . from problem analysis to initial plant operation.



One of these developments is the ion-exchange cell shown here . . . a typical Dorr design for chemical applications. Its exclusive features provide . . .

- **Minimum dilution of solutions** treated, through use of air-dome operation with automatic level control.
- **Maximum use of cell volume** by elimination of inert supporting medium for exchange resins, through use of non-clogging under-drain distributors.

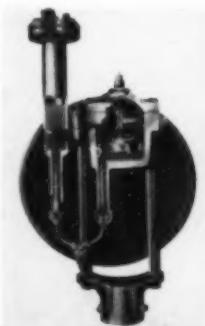
Better tools TODAY to meet tomorrow's demand



EQUIPMENT NEWS, cont. . .

heating load. During the remainder of the rotation there is oscillation, and the heating load is energized.

Cycle times of 3, 7½, 12, 18, 30 and 72 sec. can be obtained on the new controller with the set of gears provided. Proportional band is continuously adjustable between 1 and 3 percent. Signal lamps on the front of the case indicate on-and-off operation of the control unit relay.—Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.



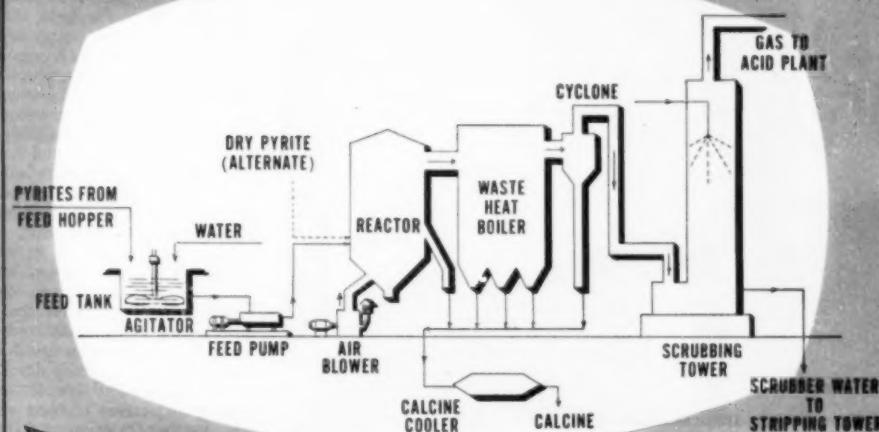
**Improved Flow Meter
For Higher Accuracy**

Higher sustained accuracy and easier maintenance are claimed as the result of five improvements in the design of flow meters:

1. Pressure-seal bearing is lubricated at the factory to eliminate periodic maintenance lubrication. Leak-proof at working pressures, the bearing uses no springs and needs no mechanical adjustments.
2. Plastic check floats are kept clean by complete submersion in mercury.
3. Improved U-bend has metal-to-metal compression seals, tested at 10,000 psi, for full protection against mercury loss. Replaceable seats are made of hardened stainless steel; there are no gaskets to replace.
4. Damping plug is calibrated to simplify damping adjustments.
5. New stainless steel ball-chain transmits straight-line float motion to recording pen assembly without friction and errors of angularity.—The Foxboro Co., Foxboro, Mass.

Pressure Transducers Put Out Electric Signals

Gage or differential pressures to 4,000 psi, and absolute pressures to 2,000 psi, can be converted into changes in resistance-ratio or voltage with these new transducers.—Rahm Instruments, Inc., 12 W. Broadway, New York 7, N. Y.



Now...HIGH STRENGTH SO_2
and accurate temperature control

**from sulphide roasting
... with the Dorco FluoSolids System.***

Sulphuric acid manufacturers faced with a shortage of elemental sulphur are finding in FluoSolids an economically feasible means of tapping sulphides as an alternate source of SO_2 . Fifteen FluoSolids Systems are now under construction to furnish SO_2 gas for contact acid plants.

For detailed information about FluoSolids — a distinct departure from conventional roasters — ask for a copy of Dorco Bulletin No. 7500. Just write to The Dorco Company, Stamford, Conn., or in Canada, The Dorco Company, 80 Richmond St. West, Toronto 1.

*FluoSolids is a trademark of The Dorco Company, Reg. U. S. Pat. Off.

Facts on FluoSolids Systems
for SO_2 Production ...

Gas Strength will average 10-15% SO_2 from pyrite and other sulphides.

Gas Cleaning Equipment is smaller than with conventional methods.

Feed can be coarse or very fine — dry or wet.

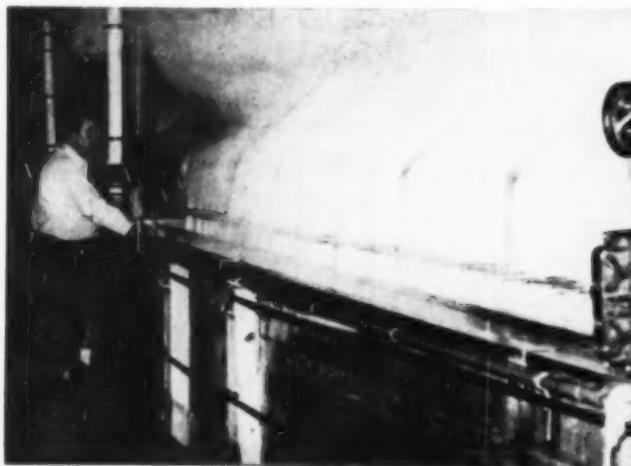
Low Maintenance because no moving parts are exposed to high temperatures.

No Extraneous Fuel Needed once calcining temperature is reached.

Complete Instrumentation minimizes the "human factor" in operation.



Better tools TODAY to meet tomorrow's demand



More and cheaper—sulphonated ester with unusual properties when applied in dye bath.

Out of the Rarity Bracket

Now, highly sulphonated fats and oils for the textile industry are being economically produced in large volume by a unique commercial process.

A new streamlined process makes Dexter Chemical Corp. the world's largest producer of highly sulphonated fats and oils. Textile-industry demand for these chemicals has been increasing steadily. Their valuable properties hinge on 100 percent sulphonation.

With the new installation, for example, the company has effectively supplied the market with a wool protective agent. Called Maxitol No. 10, it is used primarily in chromate dyeing and shrinkproofing of wool.

Because it is highly sulphonated, it forms a stable Maxitol-keratin compound and cannot be rinsed off. It provides the wool with the oily nourishment it needs to give it fullness, life, softness and suppleness; it enhances the strength, carding, spinning and wearing characteristics of the fibers. This contrasts sharply with conventional oils which are connected to wool fibers merely by absorption.

Furthermore, unlike conventional wood oils, Maxitol No. 10 is slightly hygroscopic, delaying loss of moisture even more effectively than glycerine, especially at high temperatures. When

treated wool is dried at high temperatures, it will retain the last traces of moisture for a longer time than ordinary wool. In dyeing and carbonizing, it will not be nearly as susceptible to injury. High sulphonation gives this chemical the additional properties of good wetting and penetration so that it is distributed uniformly over the entire surface of the goods.

For many years, the company has had a highly sulphonated synthetic ester, Atolene RW, which displayed remarkable wetting and dye levelling properties and which was costly to produce under the older conventional process. Today, Atolene RW is produced in volume on the high-speed equipment at a price attractively competitive with conventional wetting agents and dye levellers. And it is thus far the only highly sulphonated synthetic ester on the market.

There is still another, more highly specialized, need for 100 percent sulphonated fat in the production of viscose. A manufacturing process calls for the addition to the viscose mixture of a small amount of fatty acid or fat with a degree of sulphonation of 100

percent. This material peptizes the partially hydrolyzed resin suspension in the mixture to the degree where the solution is rendered completely clear.

The first completely sulphonated product made for this application was produced by a costly, laborious German process; the present accepted product is still being made this way. Dexter has speeded up and improved the process to the point where its product, called Maxitol B anticlouding agent, is almost 20 percent lower in cost than older counterparts.

Most essential feature in the high sulphonation process is low temperature cooling. Dexter engineers concentrated their efforts on the search for suitable temperature control devices. Finding none compatible with their system, they finally developed a flexible heating and low temperature cooling installation of their own design. Further development and experimentation fitted this innovation to a mechanical system which facilitates smooth, uninterrupted flow of all steps essential to the process. Full automatic control of the process is accomplished by means of continuous indicating instruments. The result—Dexter has wrought what it believes to be the first high-speed, high sulphonation installation in the world.—Dexter Chemical Corp., Blvd. P. O. Box 1, New York 59.

Adhesive

Combination of low-cost chemicals, a waste disposal byproduct, can be used as an adhesive or adhesive extender.

From the sulphite waste liquor of its pulp and paper mills, Crown Zellerbach Corp. is commercially producing Orzan, consisting essentially of ammonium lignin sulphonate and wood sugar.

It can be used as an adhesive or adhesive extender, as a wetting agent, as a dispersing agent for water insoluble material, as a raw material source for other organic chemicals. It also acts as a soil conditioner and as a yeast nutrient. Reasons for the product's apparent stimulation to plant growth are being investigated at Oregon State College under Crown Zellerbach sponsorship.

The new development is a byproduct of the company's long-term program for waste disposal which involves substitution of ammonia-base sulphite

acid for the usual calcium base. The ammonia base allows easier concentration of the liquor and recovery of sulphur dioxide if the resultant concentrate is burned as fuel.

Evaporation equipment which will reduce the waste liquor to 50 percent solids suitable for some commercial uses and for burning the plant process heat is scheduled for the company's Lebanon, Ore., mill. Orzan spray-dried solids will be produced only on an experimental basis, with installation of production equipment governed by demand.

Evaporation equipment which will reduce the waste liquor to 50 percent solids suitable for some commercial uses and for burning the plant process heat is scheduled for the company's Lebanon, Ore., mill. Orzan spray-dried solids will be produced only on an experimental basis, with installation of production equipment governed by demand.

Crown Zellerbach is making the new material available to industry to explore the demand and develop new uses. Price of the Orzan solid is \$65 per ton, and of Orzan liquid \$20 per ton, fob., Lebanon, Ore. — Crown Zellerbach Corp., Lebanon, Ore.

Lubricant

When used on gears and bearings, its lead content means resistance to wear, moisture, chemicals.

Lead has long been regarded as the finest of lubricants. Its use in metallic form has been hindered by the lack of a successful method to keep it from settling out of suspension. Knapp Mills, Inc., reports that it has gotten around the difficulty and the result is its new heavy duty grease lubricant, Lead-Lube.

Credit for the development goes to advances in the field of powdered metallurgy which have made metallic lead available in dust form. Consequently, Knapp was able to develop a homogenizing process related in principle to the flotation process for ore treatment.

Function of the metallic lead in Lead-Lube is to form self-lubricating surfaces over all the wearing parts of gears and bearings, so that the actual surfaces will be protected from wear. In the case of older equipment, the lead is said to resurface pits and scores.

Five years of practical tests have shown that surfaces formed by Lead-Lube will materially increase the life of machinery under severe corrosive conditions.

Lead-Lube has a base grease which will not break down under conditions

IN BRIEF—A capsule listing of this month's newsworthy products

It's New . . .	It's Good For . . .	See Page . . .
Sulphonated Products	Giving unique properties to textiles	239
Adhesive	Extender, wetting or dispersing agent, too	239
Lubricant	Increasing machinery life under severe conditions	231
Odorless Latex	Foamed cushioning	231
Resin	Imparting superior wet strength to paper	231
Lead Stop	New use for asbestos fibers	231
Toxaphene	Erasing boll weevils, boll worms, grasshoppers	232
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Carbon Black	More tire mileage than standard HAF grades	234
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Organics	Dystuffa, pharmaceuticals, surface coatings	236
Phenolic Plastic	Better adhesion characteristics	238
Plastic Tubing	Chemical resistance, ease of fabrication	238
Concrete	Strength—twice that of ordinary varieties	238
Pigment	Twice the coloring power of older blues	240
Laminated Sheets	Steel's tensile strength, chemical resistance	240
d-Sorbitol	More for your money	240
Pentahydride Borax	Making up for boron deficiencies in soil	240
Nonyl Phenol	Wetting and emulsifying agents, oil additives	240

involving corrosion, high temperature, high speed and high pressure, until after the lead coatings have been formed over the wearing parts. — Knapp Mills, Inc., 125 Broad St., New York 4, N. Y.

Odorless Latex

For foamed cushioning—strength and toughness, no objectionable chemical odor.

Goodyear Tire & Rubber researchers found the styrene part of the synthetic rubber latex to be responsible for the objectionable odor in foamed rubber.

To solve the problem, company researchers have come up with a product described as cold butadiene. Styrene, used heretofore with butadiene in latex production, has been eliminated.

Strength and toughness have not been sacrificed. Although polybutadiene by the hot process solved the odor problem, strength and toughness were unsatisfactory.

Identified as Type X-653, the new latex is being produced on a pilot plant scale at the Goodyear-operated, government-owned plant in Akron.— Goodyear Tire & Rubber Co., Akron, Ohio.

Resin

Excels urea and melamine-formaldehyde resins in imparting wet strength to paper.

Not only laboratory tests, but production runs in leading papermaking plants have shown that a new amino-plast resin delivers up to 33 percent more wet tensile strength than equal amounts of urea resins. Developed by Libbey-Owens-Ford Glass Co.'s Plaskon Division, it has also shown significant improvements over melamine-formaldehyde types.

Consequently, the cost of producing paper with any particular degree

of wet strength would be considerably less when using the new resin instead of the other types.

Called Aminoplast 348-11L, it also has the important advantages of being readily soluble, even in ice water, and may be added by any of the standard methods for introducing wet strength resins into the papermaking operation.

A clear, light brown liquid, it remains stable for at least 90 days.— Plaskon Division, Libbey-Owens-Ford Glass Co., Toledo, Ohio.

Lead Stop

Sealing tank car leaks—a new use for asbestos fibers.

Liquids, such as bulk wines, acids, molasses, syrups, edible oils, liquid pitch and fuel oil are often shipped for long distances in tank cars.

In the past when tiny leaks developed in the tanks, the only way to prevent serious loss by leakage was to side-track the leaking car and transfer the liquid contents to another car or tank.

Now it has been found that a small amount of asbestos fiber, put in with the liquid, will stop these pin holes until the tank can get through to its destination and be thoroughly overhauled.

The Assn. of American Railroads has advised its members of this use of asbestos fiber. They explain that when the fine filaments are put into the liquid in the tank car, they follow any flow or current present in the tank. The currents carry them to the leak where they mat across the crevice to form a plug.

For best results a small amount of the liquid in the tank is drawn off into a pail. Into this the asbestos is mixed to form a slurry which is then poured into the tank. This assures faster dispersion of the asbestos and quicker plugging of the leak.—Hercules Filter Corp., 204 21st Ave., Paterson, N. J.



Applied in a variety of ways, toxaphene stops destruction like that in corn field, above, ravaged by grasshoppers.



Toxaphene Moves Into High

Third plant since the product's introduction five years ago is now under construction. It will bring output of the wide-range insecticide to about 100 million pounds a year.

Last year Hercules Powder Co. sold all the toxaphene it could turn out—something in the neighborhood of 75 million pounds.

This year the company started building its third toxaphene plant—only five years after completion of the first unit in Brunswick, Ga. Hercules developed toxaphene and is still sole producer.

Why is its baby so healthy?

• Where competitive insecticides must often team up to fight more than one pest, toxaphene tackles a wide range. (The company's latest booklet includes a list of 74 destructive insects for which it is officially recommended by federal and many state authorities.)

• Recent work on controlling forage crop insects considerably enlarged the market for toxaphene. This was an important point in the decision to build the new plant.

• Hercules, since 1948, has worked hard at an educational program for entomologists, processors, dealers and farmers. In part an altruistic move, this in itself paid dividends in expanding toxaphene's market—and shows every sign of continuing to do so.

► **Quick Succession**—It was only last May that the second toxaphene plant, located at Hattiesburg, Miss., commenced operation. Shortage of chlorine held down output. At the new plant being built at Henderson, Nev., chlorine will be supplied by Stauffer

Chemical Co.'s adjacent caustic-chlorine plant. A \$2.5 million project, it will increase capacity by 25 percent when it goes on stream early in 1953.

Since the beginning toxaphene production has been increasing apace with the other big organic insecticides, DDT and BHC. In 1948 the score was: DDT, 20 million pounds; BHC, 18 million; toxaphene, 13 million. Last year the output was 120 million pounds each for DDT and BHC, about 75 million for toxaphene. In 1953 toxaphene is expected to hit the 100-million-pound-a-year mark.

The Dept. of Agriculture estimates that requirements for toxaphene during the 1951-52 crop season will be 130 percent of that in 1950-51. Their figure for DDT is only 107 percent, for BHC, 114 percent.

Like its key competitors, toxaphene counts on the cotton belt for its largest market. Cotton insect control takes 75 to 80 percent of the output.

Unlike them, toxaphene kills all common cotton insect pests. For instance BHC and DDT must team up when both the boll worm and the boll weevil have to be dealt with. DDT handles the worm, BHC the weevil. Toxaphene handles both. Breadth of coverage is probably the largest single factor in the product's success story.

Other fast-growing outlets: for army worms and cutworms in the Midwest; for alfalfa spittlebugs. For some time

grasshopper control has been taking an appreciable cut of toxaphene output.

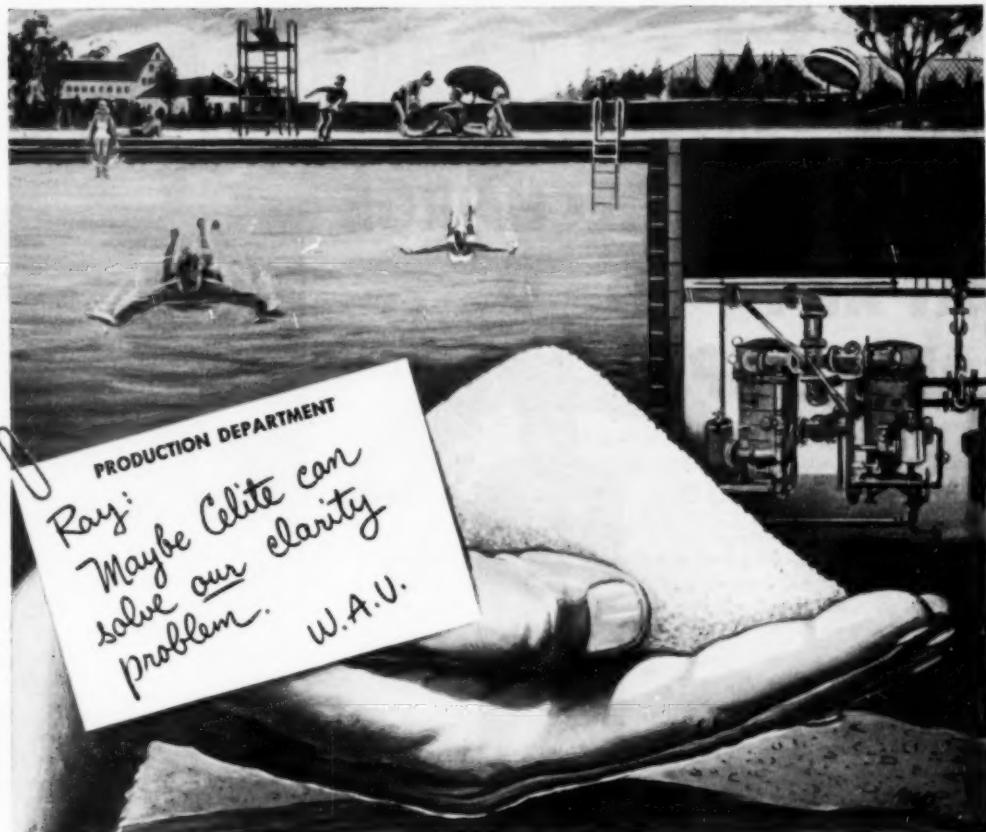
► **Engineering Story**—Behind the growth of toxaphene production from a small unit five years ago to the large continuously operated plants of today is a story of a chemical engineering development of considerable magnitude. Most chemicals involved in its manufacture are both corrosive and toxic. It is made by chlorinating camphene to 67 to 69 percent chlorine. This results in a material having the approximate empirical formula $C_{10}H_8Cl_2$. Camphene is made by isomerizing alpha-pinene, a major constituent of turpentine.

The product is a yellow waxy solid with a mild piney odor. It melts in the range of 65 to 90 deg. C., is insoluble in water but readily soluble in organic solvents.

More than 80 manufacturers now make and sell toxaphene-base insecticides. It is sold in the form of solutions, dusts and wettable powders. In the cotton belt there is a fast-growing trend toward the use of sprays. Hence there is large-scale formulation of toxaphene as an emulsifiable concentrate.

► **Educate to Sell**—Education has been the mainstay of all sales, advertising and promotion activities. The objective is to cooperate with federal, state, and local agricultural agencies in presenting facts—facts not wholly related to immediate sales of toxaphene.

Only recently, Hercules sent a letter to principal customers, withdrawing recommendations for use of toxaphene insecticides on bright leaf tobacco crops pending further research. Investigations had indicated that toxaphene might have a slight effect on the smoking flavor of the tobacco. Some of



"Fresh-up powder" for busy pool water

To keep the water in their swimming pools constantly refreshed, many operators swear by the thorough cleansing action of Celite* filtration.

By removing algae, chlorine-resistant amoebae—and other suspended impurities—Celite Filter Powders provide an uninterrupted flow of clear, clean water. They also reduce the need for chemical treatment.

The effectiveness of Celite—in this and countless other operations—can be attributed to these important

factors which make it unique among filter aids:

Carefully processed from a large and pure deposit of diatomaceous silica, Celite is available in several standard grades—each designed to trap suspended impurities of a given size and type. Whenever you reorder, you are assured of the same uniform, accurately graded powder received in your initial order. Thus, with Celite, you can count on consistent clarity and purity in your filtrates—

at highest rate of flow—month after month, year after year.

Keeping swimming pool water constantly refreshed is one of many processes in which Celite provides vital clarity. The proper grade of this filter aid will assure you the same results—regardless of your product or process. To have a Celite Filtration Engineer study your problem and offer recommendations, write Johns-Manville, Box 290, New York 16, N. Y. *No cost or obligation.*

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Johns-Manville CELITE

FILTER AIDS

HERE'S A FIRE EXTINGUISHER YOU CAN RECHARGE AT ANY AIR PUMP!

An ordinary air pump will prime this new Kidde dry chemical extinguisher with more fire-killing power than any other unit its size!

See how easy it is to recharge! Just unscrew the head, put in five pounds of dry chemical, screw the head back on and it's ready to charge from any plant or service station air pump.

And see how easy it is to operate! One hand swings this portable extinguisher into action. One finger squeezes the trigger. Poof! A cloudlike pattern of dry chemical smothers the fire while you remain safely behind a curtain of heat-absorbent powder.

This revolutionary new Kidde extinguisher is so safe, so sure, you'll find it a necessity for trucks, garages, factories—wherever there is a danger of small fires.

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3 PRESSURE GAUGE in pistol-grip handle tells you when air is needed.

4 TRIGGER ACTION gives you finger-tip control.

5 POWDER WON'T PACK. Perfect for trucks, garages, factories, etc.

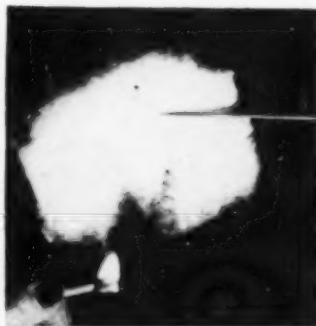
1 CHARGES AT ANY AIR PUMP. Operates at 150 lbs. pressure.

2 COVERS GREATER AREA with Kidde's cloud-like discharge pattern.

PRODUCT NEWS, cont. . .

these investigations, in fact, had been sponsored by Hercules.

Thus the company recognizes an obligation to customers while it builds acceptance in the field. The record shows the soundness of the notion.



Fire Retardant

Cotton treated with new resin will char but won't flame or smoulder at all.

Lasting fire protection for textiles is said to be afforded by American Cyanamid's new Pyroset.

Produced from an organic nitrogen compound, it is combined with phosphoric acid in water solution and applied to the textile. Thoroughly impregnated cloth is squeezed on a mangle, dried and cured.

The treatment boasts a high degree of durability, retaining its flame repellent properties after 25 dry or wet cleanings. Credit for this is given to the curing operation which probably causes the chemicals to react with the cellulose. Curing takes place in an oven at 300 deg. F. for a minute or two, depending on the type and weight of the fabric. Or it can be done more rapidly at higher temperatures.

Pyroset won't distort the hand or color of the fabric. It doesn't attract moisture, nor impair tensile strength nor brown nor lose strength when hung near radiators. It can be applied by a mill or finisher without special equipment. — Textile Resin Dept., American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y.

Carbon Black

In high tensile and high abrasion resistance, it exceeds HAF blacks.

Extensive road tests have shown that a new grade of rubber reinforcing oil furnace black gives 15 to 25 per-

Kidde

Walter Kidde & Company, Inc.,
528 Main Street, Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.

Count on HEYDEN for FORMIC ACID



More and more chemists and production men are specifying Heyden Formic Acid (90% and 85%) to assure best results in a wide variety of applications.

Make the most of this high quality formic acid in your particular process. In the manufacture of better textiles, be sure you are taking advantage of the economies and improvements it effects in its many uses.

Heyden Formic Acid has proved its value in the production of important pharmaceuticals—in the tanning of leather—in the treatment of paper—in rubber manufacture—in metal plating and numerous other industrial applications.

Shipped in 125 lb. carboys and 525 lb. stainless steel drums.

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Another Heyden product of high purity that is important in the chrome tanning of leather, making water-resistant wall paper, and dyeing and finishing of textiles. Investigate this economical raw material for your operations. Shipped in 300 lb. water-proofed fiberdrums.



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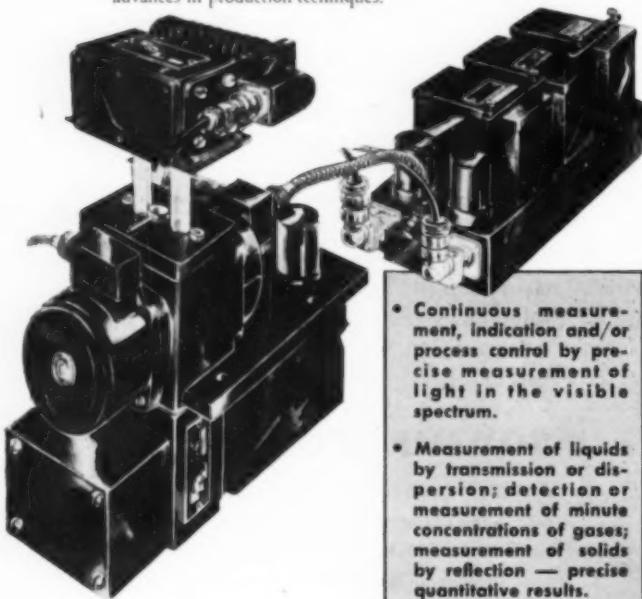
Benzaldehyde • Benzoates • Benzyl Chloride
Bromides • Chlorinated Aromatics
Cresenes • Formaldehyde • Formic Acid
Glycophosphates • Guaiacols
Hexamethylenetetramine • Medicinal Colloids
Methylene Disalicylic Acid • Paraformaldehyde
Parahydroxybenzenes • Penicillin
Pentaserythritol • Propyl Gallate • Resorcinol
Salicylates • Salicylic Acid • Streptomycin

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a precision light comparator

*a reliable highly-sensitive colorimetric instrument
for fully automatic process control
or indication by light measurement*

Colored-e provides methods of processing and control heretofore impossible, and permits marked advances in production techniques.



Typical industry users:

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Special Coating Industry
Textiles
Printing and Lithography
Public Health
Photography
Ceramics
Foodstuffs

Application engineering services can be made available to Colored-e purchasers through cooperation of Vitro Corporation of America.

- Continuous measurement, indication and/or process control by precise measurement of light in the visible spectrum.
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- Continuous duty, highly stable, moisture and explosion-proof.
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- Exceptional versatility.
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DEVELOPMENT
LABORATORIES, INC.

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NEEDHAM HGTS. 94, MASS.

PRODUCT NEWS, cont. . .

cent increased tire mileage over that provided by standard HAF grades.

Called Vulcan 6, its properties recommend it for use wherever high tensile and high abrasion resistance are of primary importance. Rubber manufacturers can now obtain superior reinforcement without having to make major changes in HAF formulations.

An oil furnace black, the product results from the initiation ten years ago of a program to meet threatened gas shortages and rising natural gas prices—Godfrey L. Cabot, Inc., 77 Franklin St., Boston 10, Mass.

Polymer Plastic Resins

For the oil, plastics, paper and paint industries.

A new series of water soluble resins have high heat resistance, nonthermoplasticity and resistance to chemicals, oils and solvents.

These characteristics are important in parting agents during plastics molding operations and in producing paper coatings.

Additional properties of bacteria resistance and dispersion characteristics would retard the rate of sedimentation of clay in oil well uses.

Other fields in which the new series may find application are for sizing, finishing, printing and coating textiles; as a dry or green strength binder for ceramics; and as tack promoters, film formers and viscosity builders for adhesives.

Called Lustrex 700 resins, they are finely divided, free flowing, off-white powders that dissolve readily in water to produce stable solutions covering a wide viscosity range.—Plastics Division, Monsanto Chemical Co., Springfield, Mass.

Organics

Four new chemicals for use in such fields as dyestuffs, pharmaceuticals, surface coatings. (123A)

Among new Heyden Chemical Corp. products offered in experimental quantities is 5-chlorosalicylic acid. It is suggested as highly efficient carrier in the dying of Dacron, Orlon, Dynel, nylon and other new synthetic fibers.

Present techniques for the piece-dyeing of Dacron call for adding salicylic or benzoic acid to the bath. Although 5-chlorosalicylic acid would be a more expensive material even when produced commercially than salicylic or benzoic acid, it is effective in lower concentrations. Other appli-

2 NEW

Victor research chemicals
now available

→ Derived from the Benzene Phosphorus Chlorides, Victor Benzene Phosphonic Acid and Benzene Phosphinic Acid are offered for your evaluation. The interesting properties of these two new compounds indicate usefulness in several commercial applications. Upon investigation, you may find them of assistance in helping to make new compounds you are seeking. Write for your experimental samples today, on your company letterhead. Our technical staff will be pleased to work with you.

BENZENE PHOSPHONIC ACID (C₆H₅PO(OH))

M. W. 158 Sp. G. 1.475
M. p. 158°C Colorless crystals
Strong dibasic acid
Soluble in water, alcohol, ether
Insoluble in benzene
Stable in air
Forms metallic salts
Solubility in water at 25.5°C:
40.3 gm/100 gm water

Suggested uses are for non-food applications, such as:
Solid acid, intermediate for forming metallic salts used as anti-fouling agents in paints, catalyst for urea formaldehyde and related resins.

BENZENE PHOSPHINIC ACID (C₆H₅PHO(OH))

M. W. 142 M.p. 82-84°C.
Strong monobasic acid Colorless crystals
Soluble in water and alcohol
Slightly soluble in ether
Stable in air
Slight characteristic phosphine odor
Forms metallic salts
Oxidizes to the phosphonic acid with ordinary oxidizing agents such as hydrogen peroxide and nitric acid.
Solubility in water at 25.5°C:
7.7 gm/100 gm water
Suggested uses are for non-food applications, such as:
General Anti oxidant
To improve film properties of cured polysiloxane resins
Accelerator for organic peroxide catalysts



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 Benzene Phosphinic Acid

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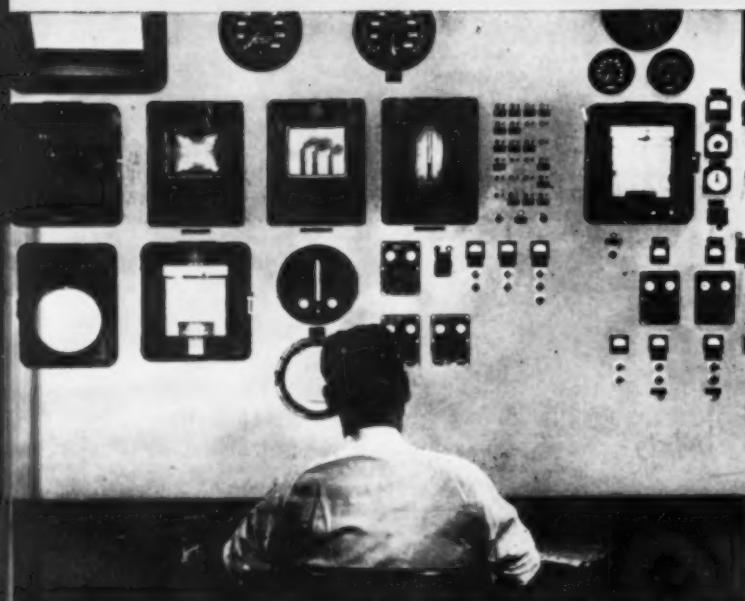
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DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

improves Centralized Control



Operator in central control room of large power station "SEES WHERE HE CAN'T LOOK". Here he watches flame conditions in boiler furnace, stack smoke discharge, and water level in boiler on "Utiliscope" screens of control panel.

Centralized control is much more effective if it brings a SENSE OF REALISM into the control room . . . if the operator can actually see what is going on outside his range of vision instead of depending upon indirect interpretations of operating conditions. The electric power industry has accepted the "Utiliscope" as an important factor in achieving better centralized control (as shown above).

The "Utiliscope" has many other uses in industry where its low cost is quickly amortized by improved operation, greater safety or savings in labor. It is surprisingly simple and requires no special skill for installation and operation. Stability and reliability are exceptional. For information on a wide variety of cost-cutting operations, ask for Bulletin 1025C.



OTHER USES—Watching flow of molten metal • Studying destructive tests of engines
Viewing nuclear research • Coordinating materials flow on conveyor.

The "Utiliscope" (Registered U.S. Patent Office)

4743

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Since 1903, Diamond has Manufactured

Quality Equipment For Industry

PRODUCT NEWS, cont. . .

cations suggested for the product include use as an intermediate for pharmaceuticals, insecticides and fine chemicals.

Metal hydroxybenzoic acid, another of the new chemicals, is suggested for use as an intermediate in the preparation of fine chemicals. Methyleno-di-o-cresotinic acid, a novel dibasic acid, also is being offered experimentally by Heyden. Uses suggested for this new product include applications in the production of specialty dyestuffs and resins for surface coatings and printing inks.

Dipentek diformal is the fourth new compound. This product is suggested as a resin ingredient.

Phenolic Plastic

Improved molding characteristics include universal flow, freedom from flashing, fast cure.

Broad application in all types of molding—transfer, plunger or regular compression—is claimed for Monsanto's phenolic plastic, Resinox GP-1000.

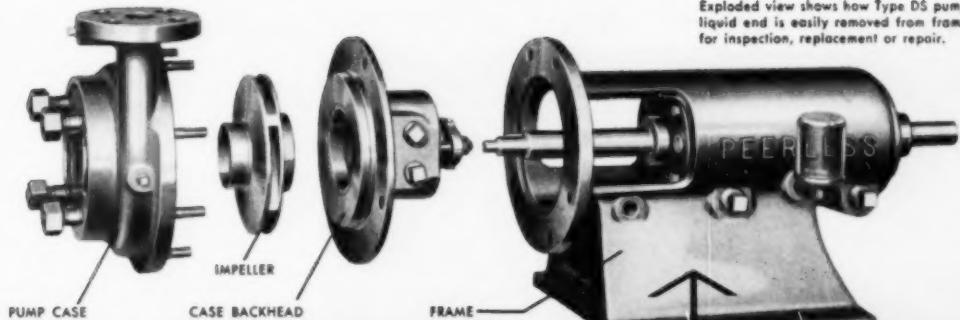
Flow characteristics of the new product are designed to permit reduction of transfer and clamping pressures and minimize the need to inventory a variety of flows. Its excellent rigidity of set is said to be reflected in outstanding mold release and less warpage on ejection. Because of its quick, easy flow, Resinox GP-1000 produces denser molded parts, relatively free from strains.

A decreased tendency to flash at higher transfer pressures conserves material and lowers finishing costs. Also its cure rates are as fast as those of any phenolic now being offered industry.—Plastics Division, Monsanto Chemical Co., Springfield, Mass.

Tubing, bar stock, rods and piping are now being made from rigid unplasticized Geon 404 by Van Dorn Iron Works, Cleveland. Outstanding chemical resistance plus ease of fabrication makes the products useful in applications such as valves, pipe fittings, hoods, trays, tanks, fume systems, acid-proof floors, wire insulation.—B. F. Goodrich Chemical Co., 324 Rose Bldg., Cleveland 15.

Plastic-fortified concrete that promises to be twice as strong as ordinary concrete has been announced. Increased resistance to cracking, corrosion, abrasion and impact is claimed for the new mixture which contains polyvinyl plastic. It is





Exploded view shows how Type DS pump liquid end is easily removed from frame for inspection, replacement or repair.

Simplicity

IS THE ESSENCE OF GOOD DESIGN!

PEERLESS
TYPE **DS**
CHEMICAL
PROCESS
PUMPS

Simplest to APPLY, INSTALL, OPERATE and SERVICE

Peerless Type DS all-purpose chemical pumps will meet all these important requirements: 1) quality construction; 2) continuity in operation; 3) moderate cost; 4) quick availability of both original units and parts; 5) easy, simple maintenance. Open or enclosed impeller construction available. Grease or oil lubrication available depending on service. Capacities range: up to 1500 gpm. Heads range: up to 231 feet. Temperatures: up to 600°F.

Heavy duty, deep groove ball thrust bearing.

Rigid one piece shaft for long bearing and packing life.

Heavy duty, deep groove ball radial bearing.



WRITE FOR BULLETIN

Completely describes and illustrates the Peerless Type DS chemical process pump. Profusely illustrated with cutaway pump views, sectional drawings, elevations and dimensional data and contains performance and complete construction details. Mail coupon today for your copy.

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Left Tank: 10-mil thickness of protective coating after 3 years' service.

Right Tank: 3-mil thickness of same system failing after 2 years.



For Your Maintenance Painting:

more Coats, or more Thickness?

Practical Pennsalt System Proved in Plant Usage with PENNPANTS

The above photo of acid storage tanks clearly illustrates the difference between good and poor paint maintenance programs. Taken at Pennsalt's Wyandotte, Mich., plant, it shows part of the results of a 3-year study of painting programs. The method was developed by actual painting crews and plant engineers . . . is not just a theoretical laboratory test.

Now Pennsalt can offer you a painting system which your own maintenance painting crew can use . . . a system which produces greater thickness of coats, with fewer number of coats. This system—using Pennsalt's own Pennpaints—was tested in actual plant use, against 62 other common paint systems.

Thicker coats, and fewer of them, not only proved more efficient, but also more economical in the long run. And when you realize that industry pays an annual maintenance bill of \$2 billion for painting alone, this new Pennsalt program begins to look pretty important, doesn't it?

Of course, the subject is too complex to be discussed in detail here. But a word from you will bring complete data to you on the run. Write: Corrosion Engineering Products Department, Pennsylvania Salt Manufacturing Co., Philadelphia 7, Pa.

Progressive Chemistry for over a Century

Pennsalt
Chemicals

PRODUCT NEWS, cont. . .

suggested for roads, floors and masonry as well as for use as a mortar to repair cracks and as a binder for masonry.—California-Texas Oil Co., 551 Fifth Ave., New York.

Ultramarine blue pigment in a new form which has about twice the coloring power of the old type has been developed. A specially-prepared zeolite mixture is used in its preparation to replace the usual clay and soda ash. The new pigment may be used to replace blue colors now being made from tungsten—a metal which is in critically short supply because of defense requirements. — Interchemical Corp., 67 West 44th St., New York.

Polyester laminated sheets are now being produced in thickness from 8 mils to $\frac{1}{4}$ in. or more. Called Iolvite, the material has the tensile strength of steel, but is lighter than aluminum or magnesium. It withstands continuous exposure to temperatures up to 350 deg. F., has low water absorption, good electrical properties, is highly resistant to chemicals. It may be fabricated into ducts, pipe, tube, tanks or molding shapes.—Industrial Organics Corp., 59-31 54th St., Maspeth 78, N. Y.

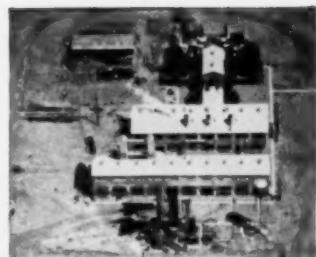
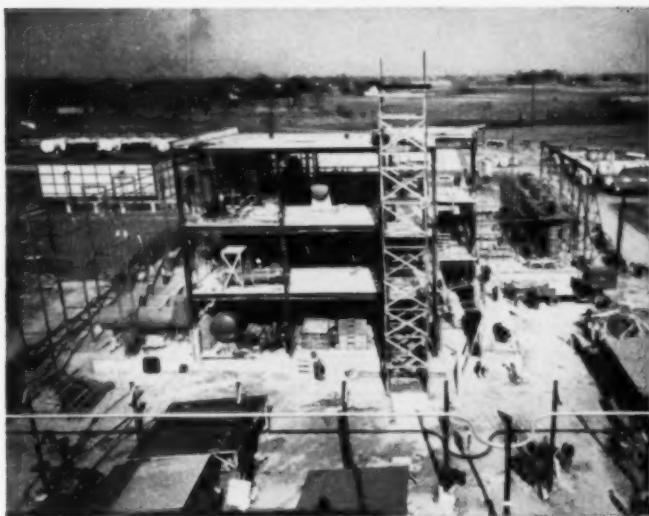
Fourth price cut since 1946 has been announced for Atlas Powder's 70 percent d-sorbitol solution. Price has been reduced $\frac{1}{2}$ cent per pound in tank car quantities. Other grades of the company's sorbitol and related polyols have also been reduced anywhere from $\frac{1}{2}$ cent to 1 cent per pound.—Atlas Industrial Chemicals Dept., Powder Co., Wilmington, Del.

Crude pentahydrate borax, under the trade name Tronabor, has been put into commercial production. It is designed for the agricultural market to make up boron deficiencies in soil.—American Potash & Chemical Corp., Trona, Calif.

Nonyl phenol in commercial quantities is now being produced by Rohm & Haas. The compound finds its widest use in the manufacture of wetting and emulsifying agents and of oil additives.—Rohm & Haas Co., Washington Sq., Philadelphia.

CE's Guide to
**NEW TECHNICAL
LITERATURE**
See inside back cover

Girdler Process News



SULPHUR FROM SOUR GAS

At the Wyoming plant of Texas Gulf Sulphur Company, sour gas, containing about 30% hydrogen sulphide is used as a source of scarce sulphur. The hydrogen sulphide is separated from the gas and converted to sulphur, and the purified gas is sold for normal use. Prime contract for engineering and constructing the facilities, including gas purification plant, sulphur recovery plant, water softening plant, sulphur storage and loading equipment, and buildings, was handled by The Girdler Corporation.

GIRDLER "PROCESS PACKAGE" includes design . . . engineering . . . construction

COORDINATING the countless details involved in construction of a new process plant can be costly to you—in engineering manhours and elapsed time. This job is greatly simplified by placing unit responsibility for engineering and construction with one reliable source.

Girdler serves the chemical, natural gas, and petroleum industries as designers, engineers, and constructors of many types of process plants. The work is supervised by experienced executives who direct a staff of engineering specialists, trained for every job requirement.

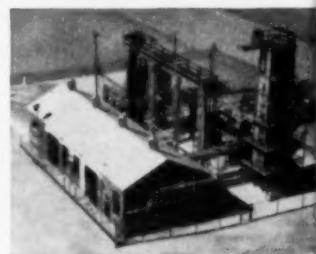
For the first step in our planning—obtaining factual data for evaluation—Girdler offers cost-plus contracts covering preliminary engineering. This includes process recommendations, flow diagrams, general equipment specifications, plot plans, cost estimates, and oper-

ating cost data. Such coordinated data simplifies planning and assures sound decisions.

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Girdler's Gas Processes Division designs and builds plants for the production, purification, or utilization of chemical process gases; purification of liquid or gaseous hydrocarbons; manufacture of organic compounds. Write for Booklet G-35. The Girdler Corporation, Gas Processes Division, Louisville 1, Ky. District Offices: San Francisco, Tulsa, Atlanta, New York. In Canada: Girdler Corp., of Canada Limited, Toronto.



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*HYGIRTOL is a trade mark of The Girdler Corporation.

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Votator Division

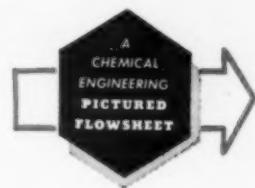
Thermex Division

PROCESS ENGINEERS • DESIGNERS AND CONSTRUCTORS • MANUFACTURERS OF CATALYSTS



No. 2 refinery of Eastern States Petroleum Co. at Houston. Platforming unit and Udex system (under construction) at left.

PLATFORMING & UDEX



Eastern States Petroleum has just put into operation the first commercial Platformer-Udex combination for production of aromatics from petroleum at its Houston, Tex., refinery. When other Platformer-Udex plants now under construction are completed (Roosevelt Oil & Refining Co. at Mount Pleasant, Mich. and Cosden Petroleum Corp. at Big Spring, Tex.), about half of the total U. S. benzene production will be from petroleum rather than coal.

Platforming is one of several methods now commercialized for catalytically reforming selected petroleum naphthas (from straight run or natural gasoline) to produce aromatics. Principal methods for separating the products so obtained include adsorption followed by fractional desorption (Arosorb process), and solvent extraction (Udex process). Distillation is ruled out because of the formation of constant boiling mixtures.

Advantages Main advantage of the Platformer-Udex combination is that with only minor adjustments it can be modified to produce mixed xylenes, ethyl benzene, paint solvents, edible oil solvents, and motor fuels in addition to benzene and toluene. Additional Udex advantages are that the diethylene glycol-water extraction medium, besides having high selectivity, shows a five-fold dissolution advantage for aromatics over paraffins. The solution is non-corrosive, non-toxic and does not emulsify with charging stocks. Essentially any mixture of aromatics and paraffins can be separated by this system.

The process is more efficient in separating hydrocarbons of the C_6-C_{10} range. Higher molecular weight stocks can be separated, however, even though these aromatics are less soluble in the extracting solution. One real drawback, is that the presence of olefins has a deleterious effect on the otherwise sharp separation.

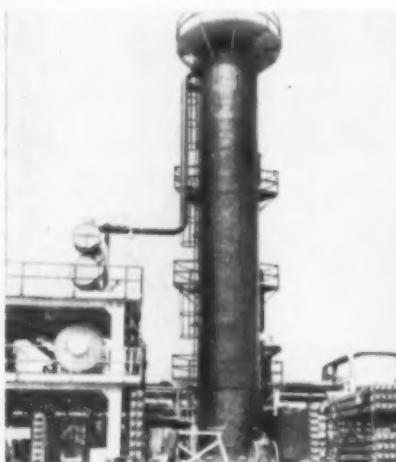
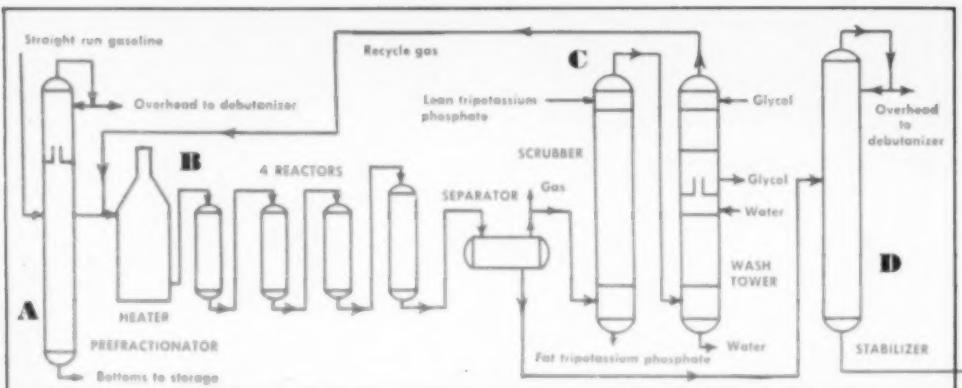
The name UDEX stands for Universal Oil Products Corp. which has licensed the process, Dow Chemical which helped make the process economically feasible through the use of diethylene glycol as the solvent, and extraction. The process is highly efficient: 99 percent of the benzene can be recovered, 96 percent of the toluene, and 91 percent of the xylenes.

Daily charge to the Udex plant, as it is now operating, is approximately 1,000 bbl. per day, 25 percent of which is benzene.

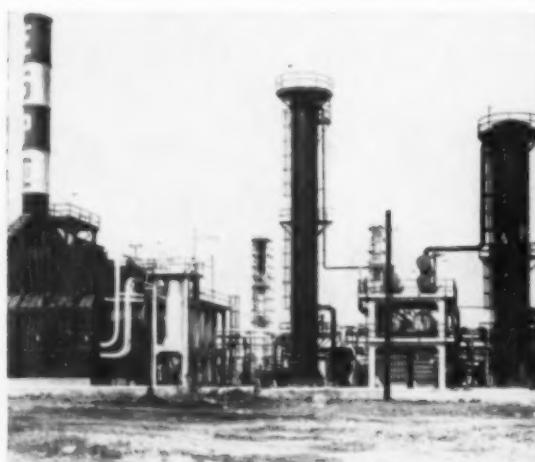
Cost of Platformer-Udex benzene is comparable to that of the coal-based material, which according to current market prices, varies between 30 and 38c. per gal.

The Eastern States Platformer is the tenth to be placed on stream. Fifteen others are currently being designed or constructed. The first Platformer went into operation in the fall of 1949 at Muskegon, Mich., an operation of Old Dutch Refining Co. Others in production include Bell Oil and Gas Co. at Grandfield, Okla., Johnson Oil Refining Co. at Cleveland, Okla., Kendall Refining Co. at Bradford, Pa., Mid-West Refineries, Inc., at Alma, Mich., and Premier Oil Refining Co. at Fort Worth, Tex.

*What is
UDEX*



A Prefractionator. Platformer charge is prepared by selecting cut producing desired end product.



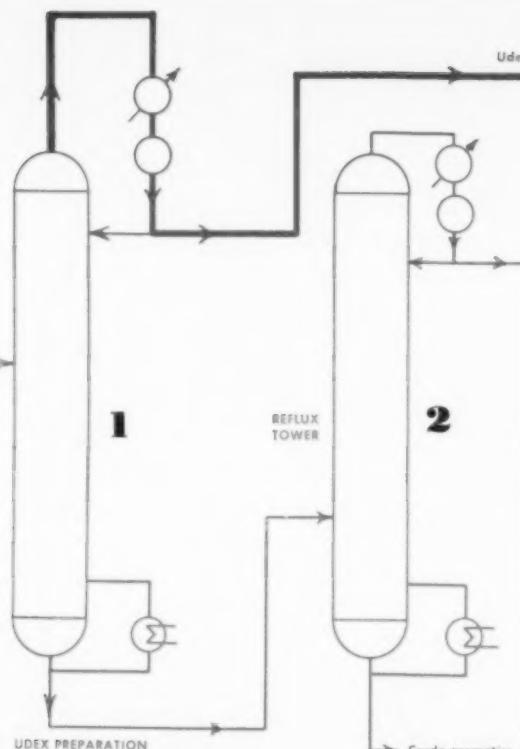
B Platformer unit. Selected naphthas are reformed at 900 deg. F. and 250 psi. with a platinum catalyst under a hydrogen atmosphere.



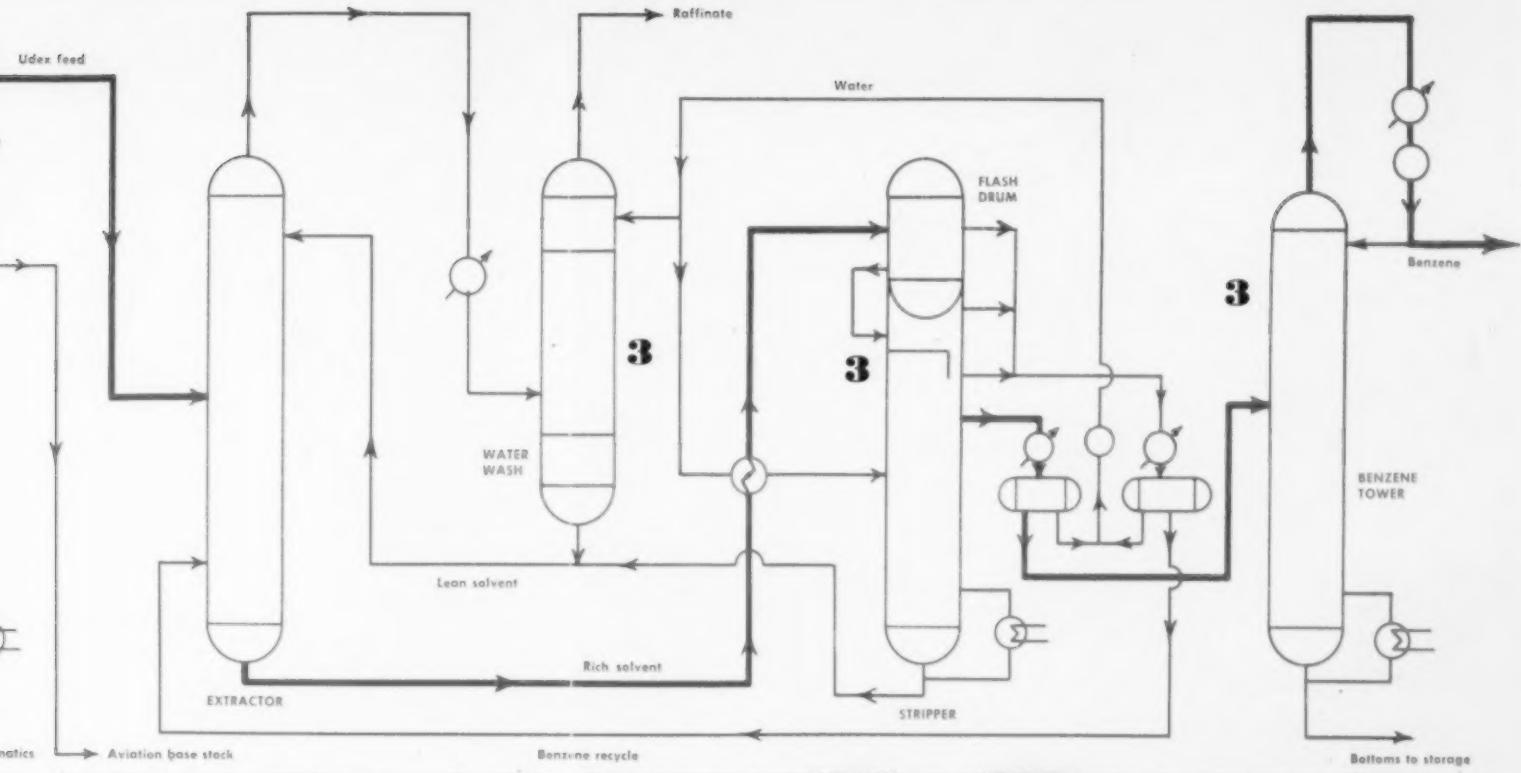
C Scrubber and water wash tower. Hydrogen recycle gas is sent through a tripotassium phosphate scrubber for removal of H₂S.



D Stabilizer tower handles product from separator. Bottoms from this tower go to Udex system.



I Udex feed preparation tower. Benzene containing fraction is taken overhead and sent to Udex unit for purification.



2 Rerun tower. Bottoms from Udex feed preparation tower go to this tower where aviation base stock is taken overhead.



3 Udex system using a mixture of diethylene glycol and water. Benzene-toluene cut is extracted, stripped of the solvent and sent to the final separator where benzene is removed as the overhead and toluene as the underflow.



Do you process materials which require centrifuging at different speeds? Or do you have several products with different filtering and washing characteristics to be processed in the same centrifugal? If so, Tolhurst Suspended Centrifugals with infinitely variable speed hydraulic drive provide the most efficient answer. By simply turning the hand wheel on the fluid drive unit, you can select exactly the speed you want for each different operation. Tachometer indicates basket speed at all times.

YOUR CHOICE OF MATERIALS

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CASE — Steel case can be lined with stainless steel, monel, rubber or other materials.

RACK AND PLOW OF COUNTERBALANCED UNLOADER—Steel, stainless steel, monel or bronze.

ACCESSORIES — Machine can be furnished with fume-tight cover, feed and spray pipes.

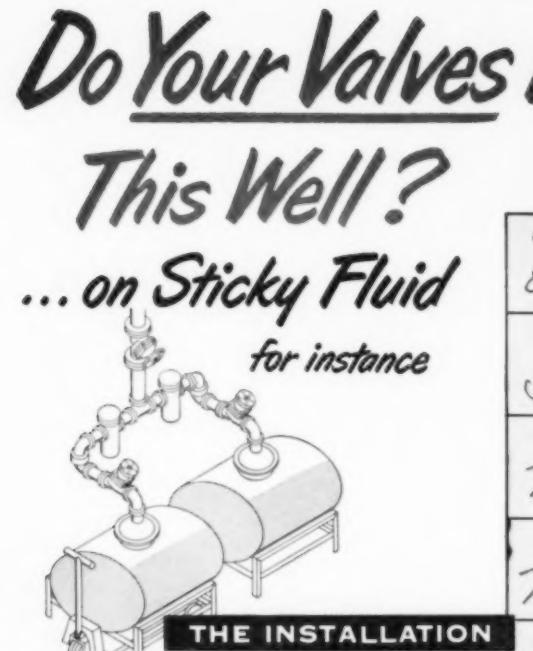
BASKET SIZES AND SPEEDS

20" diameter	0-2500 RPM
26" diameter	0-2500 RPM
32" diameter	0-1500 RPM
40" diameter	0-1500 RPM
48" diameter	0- 900 RPM

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CENTRIFUGALS DIVISION
AMERICAN MACHINE AND METALS, INC.
EAST MOLINE, ILLINOIS

May 1952—CHEMICAL ENGINEERING



Crane Diaphragm Valves on air pressurized liquid latex piping service in paint factory, Adams & Elting Division, The Glidden Company, Chicago.

THE HISTORY

Conventional valves formerly used in this service were hindered by exposure of working parts to the line fluid. The sticky latex would accumulate in the bonnet and stem threads, freezing the stem, and making valve operation difficult or impossible. With 10 or more operating cycles required daily, the plant faced considerable valve trouble and maintenance expense.

Both trouble and maintenance cost were completely eliminated by replacing with Crane Diaphragm Valves. Their fully sealed bonnet keeps the latex out of working parts. They operate smoothly and do not freeze or stick. So well is the customer satisfied with Crane Diaphragm Valves, more have been ordered for new latex lines.

The Complete Crane Line Meets All Valve Needs. That's Why
More Crane Valves Are Used Than Any Other

CRANE VALVES

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CHEMICAL ENGINEERING—May 1952

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OPERATION:

Easy - No sticking

SUITABILITY:

Fluid can't get into bonnet

MAINTENANCE COST:

None to date - None indicated

SERVICE LIFE:

No sign of wear

OPERATING RESULTS:

Production delays stopped

PRICE:

In line - No premium

AVAILABILITY:

Stock item in Crane line

THE VALVE

Crane No. 1610 Iron Body Packless Diaphragm Valves featuring separate disc and diaphragm. Neoprene diaphragm acts as bonnet seal only; isn't pinched or stressed when valve is closed. Conventional type seating makes positive closure even should diaphragm fail. High flow capacity Y-pattern body has non-restricting interior design. Available unlined or fully Neoprene lined. Consult your Crane Catalog or Crane Representative.



Why
in Any Other Make!

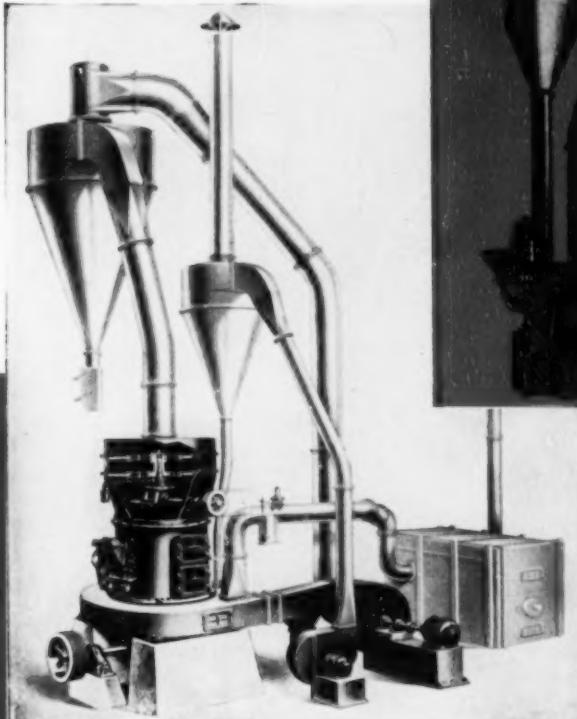
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Industrial Areas

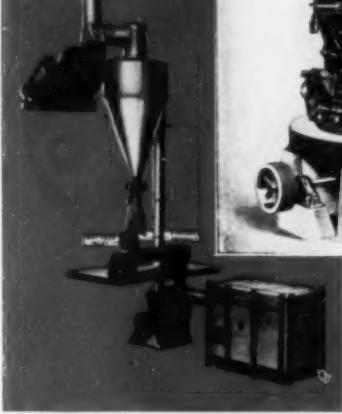
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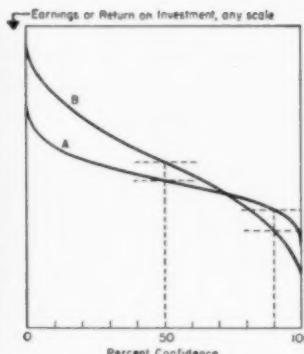
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Chemical Engineering News



MONSANTO'S Compton, at Boston meeting, reports for Socony's Matthews on . . .



Graphical Risk Factors

Risks built into cost estimates can be analyzed with simple curves whose slopes indicate the reliability of the basic data.

A novel idea in the graphical presentation of cost estimates to management was revealed last month at the Second Technical Symposium of the Boston section of the AIChE. Originator of this method is Dr. F. L. Matthews, formerly research director of Monsanto's Merrimac Division, now technical director of the Socony-Vacuum laboratories at Paulsboro, N. J. The paper was prepared by E. D. Compton of Monsanto and L. G. Gilbert of Godfrey L. Cabot, Inc.

This method offers management a quantitative tool to replace the qualitative safety factor frequently applied in the economic evaluation of engineering projects. Based on statistical science, the uncertainties of the information from which a cost estimate is prepared are evaluated in the form of a "confidence" curve. A relatively flat curve implies that the estimate has been based on fairly accurate data; a steep curve, on the other hand, serves as a warning to management that uncertainties in the basic data contribute inherently to a greater degree of risk.

CE readers will recognize a fundamental similarity between this approach and that outlined in Dr. Paul Ferencz' article in April (p. 143). Both methods involve the calculation of such statistical quantities as deviations and variances. The major contribu-

tion which the Matthews-Compton-Gilbert team has made is the ready grasp of the situation which the confidence curve permits.

► **Choice of Competing Schemes**—Just as an example, suppose that management must choose between two alternative schemes. The economics of each has been estimated from the best data available. Scheme B looks better than Scheme A at the point of 50 percent confidence, which corresponds with the mean value customarily reported. But the estimate for Scheme B is based on more questionable information, so that its confidence curve has a greater slope, intersecting Curve A in the area of higher values of confidence (see cut).

The interpretation of the graph is readily apparent. If management is willing to take the extra risk, they will favor Scheme B. But if management wants to be 90 percent sure, they will decide on Scheme A.

► **Method Needs Substantiation**—Dr. Compton is reluctant to make any premature claims for this method, insisting that the symposium paper represents only a "progress report." He is endeavoring to establish the method more firmly in actual practice before recommending its general use.

Other papers on the symposium program dealt with methods for esti-

mating capital and manufacturing costs, the language of cost estimates, and the over-all economic analysis of projects. A panel representing management, headed by A. W. Fisher, Jr., of Arthur D. Little, Inc., contributed to a lively discussion period. Here are some of the remarks of panel members:

Karl Finsterbusch (vice president, Stone & Webster Engineering Corp.)—"Many projects exceed the engineer's estimate because of changes in scope of work and other circumstances. The engineer should keep an accurate record of such changes so that he can better defend his original figures."

A. T. Daignault (treasurer, Dewey & Almy Chemical Co.)—"Every engineer engaged in preparation of cost estimates should learn as much about accounting as he can."

John Cooper (industry specialist, Massachusetts Investors Trust)—"Stockholders are more interested in the long-term return possibilities of a project than in the shortness of payout period."

Charles H. Sommer, Jr. (general manager, Merrimac Div., Monsanto Chemical Co.)—"In analyzing projects which did not measure up to estimates, the largest error was most often found in the sales manager's estimates of sales volume and selling price."

First Private Nuclear Lab Aims For Commercial Power

Last month the Kidde enterprises went into the atomic energy business. Walter Kidde Nuclear Laboratories, Inc., the first privately-financed nuclear lab, will develop commercial atomic power. It will be on Long Island and house an initial staff of 30.

Kidde will sell the services of its lab and reactor design team to industrial firms interested in using atomic power in their processes. Since serving private firms is not a proper function for government-owned laboratories, Kidde hopes to start filling the government shoes.

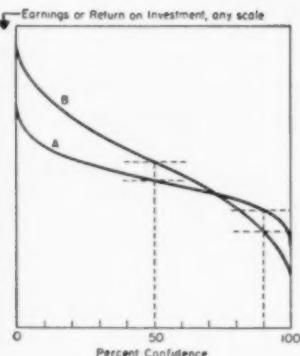
In charge of technical activities, Karl Cohen, former director of the theoretical division of the Manhattan Project Laboratories, believes an economic reactor could be built within five years and a 100,000-kw. atomic power plant would cost \$10-15 million.

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Chemical Engineering News



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Sebacic Acid Stunted?

Sebacic acid, recently fitted for big defense boots, has suddenly stopped growing. Here's a late run-down on the popular dibasic acid, including process information.

For some time, castor oil has shared a box seat with other strategic chemicals. It comes principally from Brazil, and in the event of war could be difficult to get. Today, all sebacic acid made in the U. S. is produced from castor oil.

In the last few years, present makers, prospective producers and defense officials have shown some excitement over the new uses of sebacic acid.

Normally a plasticizer, it is now used in nylon-like polymers for coating Signal Corps wire and making plastic gears. Du Pont, who makes the polymers, now uses during the defense effort about 7 million pounds of sebacic a year.

Recently, the Air Force at its Wright Field laboratories tested esters of sebacic acid in its cold weather lubricants. The sebacates worked out fine. Naturally, everyone with a process began to see bright sebacic horizons. Present sebacic production, probably 20 million pounds for 1952, would be enough to supply about 5 million gallons of these synthetic lubricants. Estimated potential lubricant needs: 40 million gallons.

At this time, sebacic acid rode high; then the bubble broke. Other dibasic acid esters were tested. Some panned out. The azelaic and adipic esters, for instance, worked out in present tests, and are expected to do as well in future trials.

Which means bad news for sebacic processors. The other two acids cost less. Sebacic sells for about 93 c. a lb., azelaic at 57 c. and adipic at 31 c.

Adipic, the cheapest of the three, can be turned out in volume; and is not based on castor oil (chief producer Du Pont makes adipic from cyclohexane derived from benzene). "It's my personal opinion that adipic will eventually be used in these lubricants," says Vice President Howard Abbott, of Hardesty Chemical Co., the nation's leading producer of sebacic.

However, sebacic has worked well in the wire coatings and gears. Despite many attempts to substitute cheaper acids, sebacic up till now has performed best. In fact, the large use of sebacic in Army field wire was one

big reason DPA placed sebacic under allocation last July. Today, producers of sebacic still must get permission from DPA before they ship any acid.

► **Present Outlook**—In the last few months, however, sebacic has been easy to get; and many in the industry feel no large call for sebacic is likely in the foreseeable future. At least, the military feels it has all the sebacic it wants now or in the immediate future, barring all-out war. DPA has issued no tax amortization write-offs; and has shown no sign of changing its mind. The allocation on sebacic, according to informed sources in Washington, may soon be lifted.

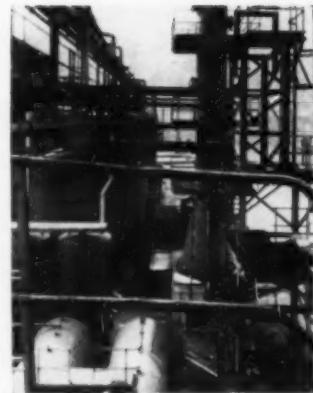
Right now, Hardesty and Rohm & Haas, the only major producers, will make enough to meet needs for sebacic acid. Both recently expanded. However, new producers could come in.

For one thing, full scale mobilization would mean loud calls for sebacic, as it would for everything else. For another, an iron-clad decision not to use sebacic in lubricants hasn't been made. Any company with a process cannot afford to forget these possibilities.

Making sebacic is a difficult process. If anyone can come up with a better, more economical method, he is bound to cash in on it. Baker Castor Oil Co., for one, has been doing pilot plant work for several years on a sebacic acid process. Despite rumors to the contrary, Baker insists it has never slackened its development work. Come hell or high taxes, Baker insists it will build when the time is right.

Most processes for making sebacic acid are patented,¹ but the Hardesty and Baker processes are not. Baker will give no details of its methods. But here is how the Hardesty operation runs at the Trafford Park works of Geigy-Hardesty Co., Ltd., the company's British collaborators. The process is based on Hardesty's with some refinements.²

► **Hardesty's Technique**—Castor oil,



Geigy-Hardesty's Plant

A British refinement

taken from large storage tanks by gear pumps, flows into fusion vessels together with caustic soda. After pre-heating, it is brought up to reaction temperature under pressure control. After fission, the capryl alcohol, which is formed along with the sodium sebacate, is distilled off. It passes to a holding tank before rectification.

Purification is done in either of two ways: (1) Sulphuric acid precipitates the free sebacic acid from the sebacate solution. The free acid is filtered off in this partially purified form. (2) Activated earths purify the sebacate.

If re-purification is to be carried out, the contents of several fusion vessels is bulked in a large storage tank, and then treated with decolorizing materials in a single operation.

After purification, the decolorizing materials are removed by filtration. Sulphuric acid, added to the filtrate, precipitates the sebacic acid, which is then recovered by filtration, finally washed and spray dried. For the highest qualities, recrystallization methods are used for purification.

Capryl alcohol, obtained as an aqueous distillate, is refined in a multi-stage, steam-heated column employing a high reflux ratio. Here, water and methyl hexyl ketone are removed.

Methyl hexyl ketone, formed in the first stage of fission reaction, reacts with α -hydroxy decanoic acid. However, the reaction is never completed; therefore a little ketone shows up in the final product. By careful control of refining conditions, the methyl hexyl ketone content can be reduced to less than 1 percent. Capryl alcohol can be made with a boiling range within 1 deg. C. (that is 179.5-180.5 deg. C.).

¹ U. S. Pats. 2,182,056 (Rohm & Haas); 2,217,516 (American Cyanamid); 2,318,762 (NOFCO); 2,477,647, 2,524,833, 2,304,602 (Du Pont).

² The Industrial Chemist, Feb. 1952, p. 72.

simpler

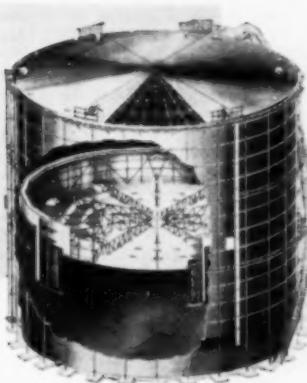
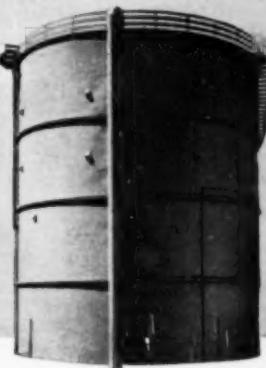
The Wiggins Gasholder has a remarkably simple design. It has none of the complicated mechanisms of old-type gasholders. No materials that can be harmed by weather.

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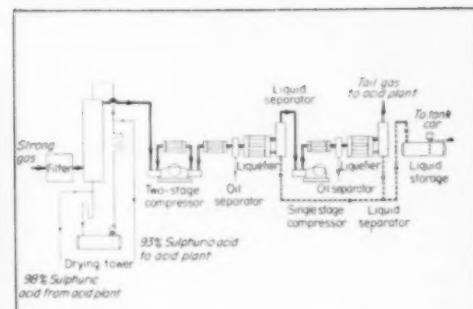


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From nickel smelter to liquid SO₂ plant: an 850-ft. pipeline.



Strength of SO₂ gas passing through it makes process economic.

Sulphur Users Get a Lift From Canada

The equivalent of 45,000 tons yearly of sulphur in the form of liquid SO₂ will soon be available in Canada at a fraction of its usual cost.

Quantities of liquid sulphur dioxide to equal the output of the rest of the free world will begin to come out of a new Canadian plant within a few months. The happy marriage of two new processes make the project economically sound.

Canadian Industries Ltd. is building the 90,000-ton-a-year plant in Copper Cliff, Ont. Adjacent to International Nickel Co.'s nickel plant, it utilizes waste smelter gases of high sulphur dioxide content.

► **Economic Inspiration**—In fact, economic inspiration for CIL's liquid sulphur dioxide process is this high concentration—more than 75 percent SO₂, instead of the usual 1.5 to 8 percent. This in turn is the result of Inco's flash-smelting process which treats ore concentrates with oxygen instead of air (at a big saving in the amount of coal needed for the roasting process).

At Copper Cliff a 75 percent recovery of sulphur dioxide is possible under only 120 psi, in a water cooled condenser. Contrast this with more usual conditions—say where an offgas contains 6 percent sulphur dioxide. To get 90 percent recovery, the liquefaction operation must be carried out at -95 deg. F. under 400 psi.

In the new process, gas from the flash-smelting furnace is delivered under pressure through a 16-in. stainless flue. The oxygen plant turns out about 350 tons of gas a day.

Glass wool filters remove residual dust. Scrubbing with 93 percent sulphuric acid dries the SO₂ gas. Thus dried, its corrosive properties are elimi-

nated and it can be handled in standard steel equipment.

After going through two-stage compressors, the dry gas passes through oil separators. Cooling with water in tube-and-shell heat exchangers condenses the sulphur dioxide as a liquid which goes off to storage. Remaining gas is further compressed, passed through an oil separator. An additional portion of gas is then liquefied by again cooling with water in a secondary liquefier.

► **Sulphuric Plant Helps**—Any sulphur dioxide still unliquefied feeds back to a sulphuric acid plant (also utilizing smelter gases) which CIL operates at the site. This plant is also the source of acid for drying the gas. Thus it too contributes to the economic success of the liquid sulphur dioxide process.

By far the major portion of SO₂ production is earmarked for the sulphite pulp mills in Ontario and neighboring Quebec. Most of the country's pulp mills now use elemental sulphur, in serious short supply, to produce the sulphur dioxide gas they need for preparation of raw cooking acid.

However, tests conducted in 1947 by the Abitibi Power & Paper Co. showed that mills can be adapted readily to the use of liquid sulphur dioxide. Formerly, they had had to burn the elemental sulphur in air to obtain the sulphur dioxide gas they needed.

Liquid sulphur dioxide is already in use in refrigeration, fruit preservation, sugar manufacturing, bleaching,

In addition to helping to supply these markets, the output at Copper Cliff even promises to provide surpluses for export.

These recent developments have also increased production of the 20-yr.-old sulphuric plant by 60 percent.

Fear Steel Fractions Might Set Pattern for Petroleum

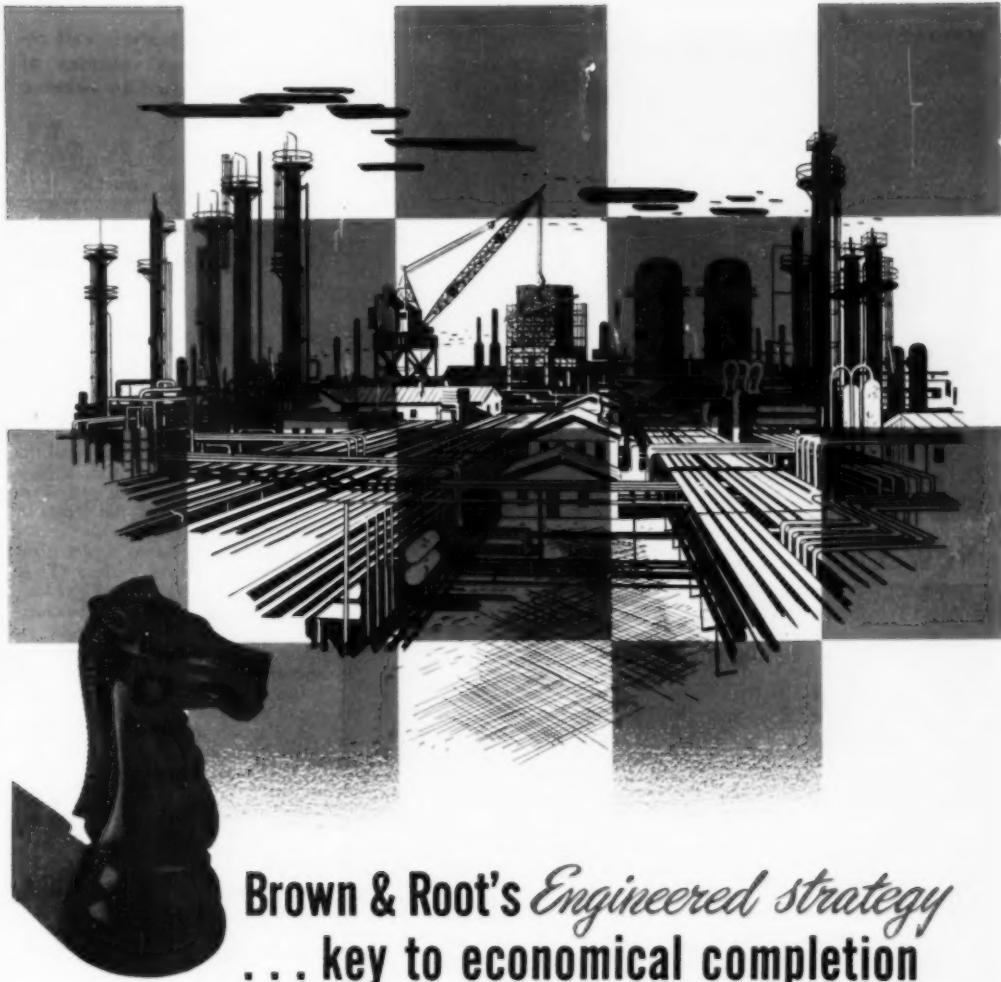
Oil and gas men were worried last month.

"The called strike in the steel industry which was stopped by President Truman's seizure of the mills carries . . . long range threats to orderly operation in the oil and gas industry," reported *The Oil & Gas Journal* on April 14.

"The pattern set in the steel controversy was being watched with special interest by the petroleum industry, because the facts and the issues are much the same. The oil industry is faced with a strike threat due to wage demands higher than allowed by the administration's stabilization rules, and industry executives say that wages cannot be increased that much without a compensating increase in petroleum prices."

Meanwhile, the oil-labor negotiations hit a snag. Earlier, the Oil Workers International Union said there would be no walkouts pending hearings run by special panels set up by the Wage Stabilization Board. But, the day before the first meeting was scheduled to begin in St. Louis, Standard Oil Co. (Ind.) said it would not participate in the hearing.

The following day Sinclair Oil Corp. announced it too was dropping out, and said it understood Utah Oil & Refining Co. would follow suit.



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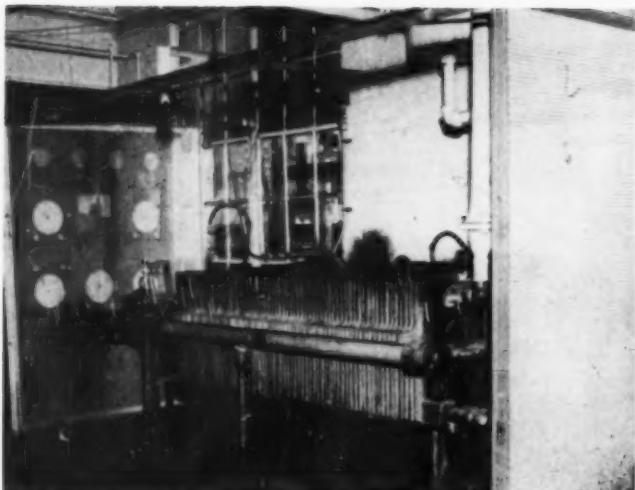


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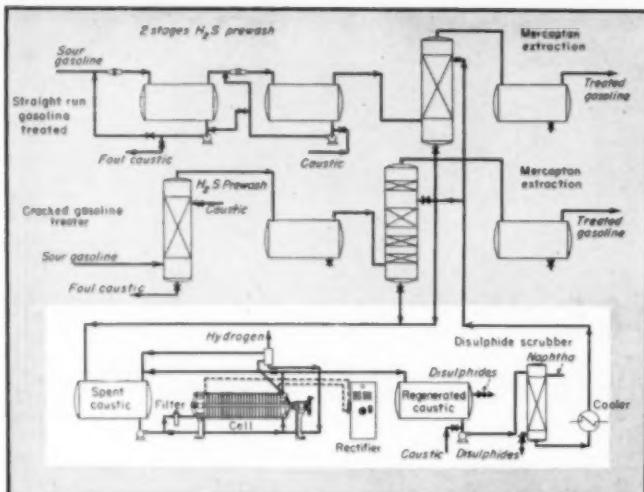
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New Cell . . .



. . . Renews Spent Caustic

One thing that refinery people are sensitive about is the amount of sulphur in the gasoline they produce. Sulphur, in the form of mercaptans, keeps lead susceptibility down so that the more mercaptans you have, the more tetraethyl lead you have to add to attain a given octane number.

To get rid of this sulphur, the refiner adds caustic—about 20 percent of the volume of the sour gasoline.

That's a lot of caustic and regenerating it with steam has been an expen-

sive, troublesome and limited operation—expensive because of high utility, maintenance and equipment costs; troublesome because of scaling of boilers and towers; limited because high-strength caustic could not be regenerated effectively and because the degree of caustic regeneration was not as high as it should have been.

Not long ago, Dr. Charles W. Rippey, a shrewd chemical engineer who had designed enough of the steam regeneration units to know something

- Electrolytic cell regenerates large volumes of caustic soda used to sweeten sour gasoline.

- Commercial unit handles 1,700 Bpd caustic.

- Saves \$80,000 a year on utilities and tetraethyl lead.

about their shortcomings, began thinking about the problem. Why couldn't an electrolytic cell do the job of regenerating? It would certainly do a better job as well as being a lot cheaper and easier to maintain.

The idea looked promising and the American Development Co., a New York firm specializing in petroleum processing, worked out the details of process and equipment.

It wasn't long before a pilot plant was operating at the Ashland Oil & Refining Co., Ashland, Ky. Not long after—in December 1951—a commercial unit big enough to handle an 8,500-bbl. gasoline plant was up and operating at Ashland.

Gasoline treating operations consist of two steps:

1. Prewashing with caustic soda solution gets rid of hydrogen sulphide. Caustic used in prewashing is converted to sodium acid sulphide and must be disposed of.

2. Caustic soda takes out mercaptans from the hydrogen sulphide-free gasoline in countercurrent packed towers. Caustic used in mercaptan absorption is continuously regenerated, returned to the extracting columns.

► **Regenerator Is Simple**—The regenerating unit consists of 60 electrolytic cells in series.

A direct current flowing through these renewers spent caustic. Electrodes are nickel-plated cast iron, either 24 or 36 in. square by 1 in. thick and separated by rubber-gasketed vulcanized asbestos diaphragms. The cut (p. 256) shows how the electrolyzer plate assembly is put together. The two plates have a $\frac{1}{8}$ in. recess to accommodate the flow of caustic.

Each unit consists of an anode oxidation plate and a cathode hydrogen plate separated by an asbestos diaphragm. Four holes in the plates form headers through which caustic flows. Spent caustic enters the lower port, flows upward and diagonally to the top port before entering the outlet header.

A similar set of ports is provided for the cathode hydrogen plates. These

**Here's what
we meant by**

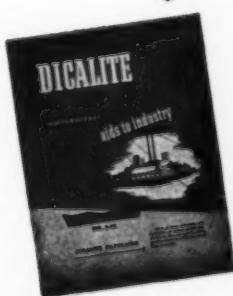


*Need help in
MAKING FILTERAIDS
GO FARTHER?*

**A survey by a Dicalite Engineer enabled
this manufacturer to cut filteraid usage
by 66½% per gallon of throughput**

One of the many products in this manufacturer's line is varnish. It was being filtered by precoat only, using 100 lbs. of filteraid to deposit on the cloths of a 200-sq. ft. plate and frame press before starting to filter each 1000-gal. batch. A survey by a Dicalite engineer led to saving both time and filteraid. First, a switch was made to a higher-flowing grade of Dicalite filteraid. Only 25 lbs. of this material (Dicalite 4200) was used for the precoat, but 75 lbs. were used in continuous addition to the varnish as it was being filtered. In this way 3,000 gallons were filtered with satisfactory clarity before the press needed cleaning. RESULT: 1) 100 lbs. of Dicalite filtered 3,000 gallons instead of the 1,000 gallons put through by the former method; 2) cycle length was tripled, so that two press cleanings were eliminated in filtering 3,000 gallons and saved considerable down time and overtime. Such spectacular savings are not always possible, but our engineers find many cases where filteraid consumption could be reduced 10% to 15% without any ill effects to operation or product quality. If you feel that a check of your filtration operation or stretching your available supply of filteraid will be helpful, or if you have a current filtration problem, write our nearest office. A Dicalite engineer will gladly call at your convenience.

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Sulfur Recovery

by automatic measurement
of SO₂ in vent gas

with this

continuously
recording

PLANT STREAM ANALYZER

S up the flue = \$\$ gone cloud-hunting . . .

An accurate, continuous check on the percentage of SO₂ present in the vent gas is a simple first step toward reducing this needless loss of sulfur. In this application, this continuously recording Plant Stream Analyzer has a sensitivity of 0.01% concentration using a full-scale deflection of 1% on the recording indicator. Strong absorption of infrared by SO₂ assures high sensitivity to this compound in the dry state.

This is only one of the countless applications of this sensitive, reliable, sturdy instrument in control situations where the concentration of an infrared absorber in the process stream is a critical index of operation. In many cases, the adaptation of the instrument for automatic control of the process itself is realizing huge additional savings.

► WRITE TODAY FOR BULLETIN 36.

PROCESS CONTROLS

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NEWS, cont. . .

permit circulation of spent caustic soda solution and the release of hydrogen gas. When the 60 electrolyzer plates, separated by diaphragms, are sealed together, the holes form four channels the entire length of the cell.

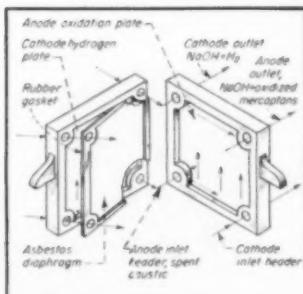
The electrolyzer capacity is dependent upon mercaptan oxidation requirements and flow rates. The 24 and 36 in. cells are able to utilize 45 kw. and 70 kw. respectively while flow rates of 1,500 Bpd and 3,000 Bpd are considered nominal.

► **How Cell Operates**—Spent caustic from the absorbers is charged into the spent caustic storage tank. This caustic is then pumped through a filter and into the anode plates of the regenerator. A slip stream, charged into the cathode plates, sweeps each plate of hydrogen gas and decreases overvoltage. Nascent oxygen, generated at the surface of the anode, oxidizes the sodium mercaptides to disulphides which are carried out of the cell to the regenerated caustic tank. The nascent oxygen is developed in the cell by electrolysis of part of the water present in the caustic solution.

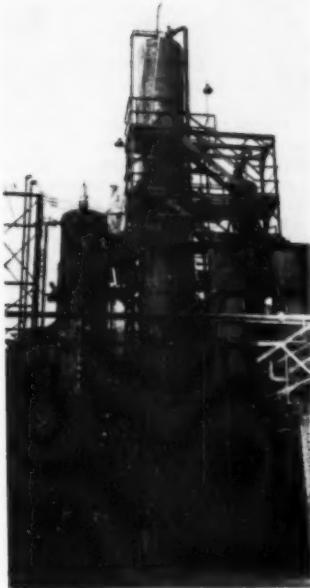
Disulphides separate from the regenerated caustics by settling and are periodically removed. Final traces of disulphides are washed out by passing the caustic through naphtha in a disulphide scrubber packed with 1-in. carbon raschig rings. Naphtha is changed periodically when saturated with disulphides. The regenerated caustic leaving the disulphide scrubber is returned to the mercaptan absorbers.

Hydrogen is inert to reaction at the cell conditions and is carried out in the caustic solution to an elevated disengaging drum where it is vented. Caustic is returned to the cathode inlet header. An overflow stream from the disengaging drum is directed to the spent caustic tank.

► **Operating Data**—The Ashland plant handles 3,500 bbl. of straight run gasoline and 5,000 bbl. of Dubbs gasoline



COMPONENTS of the electrolytic cell.



CONVENTIONAL steam regeneration

per day. Sweetening these takes 1,700 bbl. of caustic. The cell requires about 40 kw. to remove 215 lb. of mercaptans per day. The amount of mercaptan sulphur removed (in pounds) from the gasoline and from the caustic solution is the basis of plant balance.

► Operating Costs—The table below shows how utility costs and tetraethyl lead savings for electrolytic regeneration stack up against steam regeneration. Calculations are based on an 8,500 bbl-per-day gasoline treating unit. Figures are dollars per 1,000 bbl. of gasoline treated.

Electrolytic Cell Slashes Costs of Utilities & TEP

	Old	New	Savings
Steam	\$15.47	\$0.56	
Water	0.30	0.05	
Electricity	0.13	1.26	
	15.90	1.87	14.03
TEL	\$285.00	\$270.00	15.00
	Total Savings		\$29.03

► Six Major Advantages—Electrolytic regeneration boasts the following advantages over steam:

- Slashes operating utilities costs from \$15.90 per 1,000 bbl. of gasoline treated to \$1.87.
 - Lowers maintenance costs by eliminating high temperature heat exchangers, coolers and pumps. The absence of sodium sulphide at high temperatures helps keep the usual high rates of corrosion down.
 - Reduces capital costs through simple design of equipment.
 - Eliminates nuisance of mercap-

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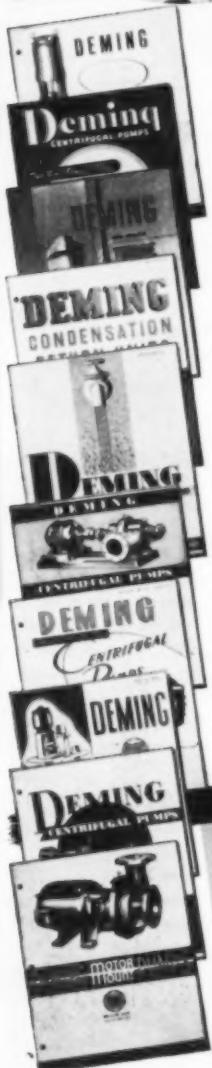
The extensive Deming line makes it possible to "pinpoint" the right pumps for specified needs.

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DEMING Industrial PUMPS

News, cont. . .

tan vapors through formation of liquid disulphides.

- Use of less tetraethyl lead saves \$15 per thousand barrels of gasoline blend.

- Cuts inhibitor needs in half. Heated caustics from steam regeneration resinify organic matter extracted from sour gasoline and contribute to the high copper dish gums and decrease inhibitor susceptibility.

► **Three Disadvantages**—Here's how the other side of electrolytic regeneration shows up:

- High amperage and voltage necessitate extra safety precautions.

- Plant treating solutions must be filtered to keep cell diaphragm clean.

- Cell and rectifier must be housed to keep them dry.

► **Pays Out Fast**—Lastly, total cost of the installation is less than for steam regeneration. Major maintenance is the replacement of the cell diaphragms—about once a year. Cost is close to \$900. Operating and TEL savings should repay total capital outlay for the electrolytic installation in a relatively short time—usually in a year.

Monsanto Tries to Nip Krilium Rumors in Bud

"Krilium fell flat on its soil-conditioning face."

During the next few months, tests in which "negative results" from the use of Krilium soil conditioner will be reported.

Such so-called failures would fall into two classes, according to producer Monsanto and sales manager Charles Zorsch. Amateur soil and garden enthusiasts will get poor results because they won't know how to apply the chemical.

Some technical cooperators will file negative. Reason: In some cases the concentration of Krilium will have been deliberately kept low. These tests will be technically rated unsuccessful even when indications are that a higher concentration would give favorable results.

In other tests temperature and moisture conditions will adversely affect results, as will lack of plant food. Application methods are sometimes misunderstood. Also, a number of test plots in the same area are often needed to find the ideal depth and rate of treatment. "These factors should be remembered when you hear a report that Krilium soil conditioner has fallen flat on its face in a given test," comments Zorsch.

Meanwhile, Monsanto will sell no Krilium until the economics and performance of the product is fully evaluated in a specific market area.

(A Quick Quiz on modern pH advancements)

Do you know...



That Beckman pioneered modern glass electrode pH equipment?

Until Beckman pH instruments were developed, glass electrode pH equipment was a cumbersome, complicated laboratory curiosity. It was Beckman that pioneered today's simple, compact, highly accurate and completely dependable glass electrode pH equipment!



That Beckman pioneered virtually every major development in modern glass electrode pH equipment?

Such far-reaching advancements as the High pH Glass Electrode . . . the High Temperature Glass Electrode . . . the Unusually Rugged "X-9" Glass Electrode . . . as well as a wide range of other vitally important advancements in glass electrode pH instrumentation, were all pioneered by Beckman. Many of these advancements are still available exclusively in Beckman equipment!



That Beckman offers the industry's most complete line of glass electrode pH instruments?

Included in the complete Beckman line are instruments specially designed to combine the high precision and wide versatility necessary for advanced research, medical and laboratory applications . . . others that combine maximum simplicity and high accuracy with complete portability for plant and field applications . . . still others that combine maximum simplicity and high accuracy with the plug-in convenience of full AC operation . . . plus completely automatic pH equipment for continuous pH indication, recording and control on large-scale processing applications.



WETHER you manufacture food products or treat sewage . . . do metal plating or refine crude oil . . . make textiles or process ore—in fact, no matter WHAT your field of operation . . . if you have not yet determined whether Beckman pH Control can be used to advantage in your operations—possibly it already BEING used to cut costs by your competitors—let us study your processes and make helpful recommendations. No obligation, of course. BECKMAN INSTRUMENTS INC., SOUTH PASADENA 14, CALIFORNIA. Factory Service Branches: New York, Chicago, Los Angeles.

For an informative, non-technical outline of modern pH control — what it is and how it's used — send for this free booklet "What Every Executive Should Know About pH." Ask for Data File 1-141

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That Beckman also provides the industry's most complete line of modern glass electrodes?

Although glass electrode pH instruments are the most efficient pH equipment obtainable, no glass electrode pH instrument is better than the versatility, accuracy and dependability of the electrode assemblies available for use with it.

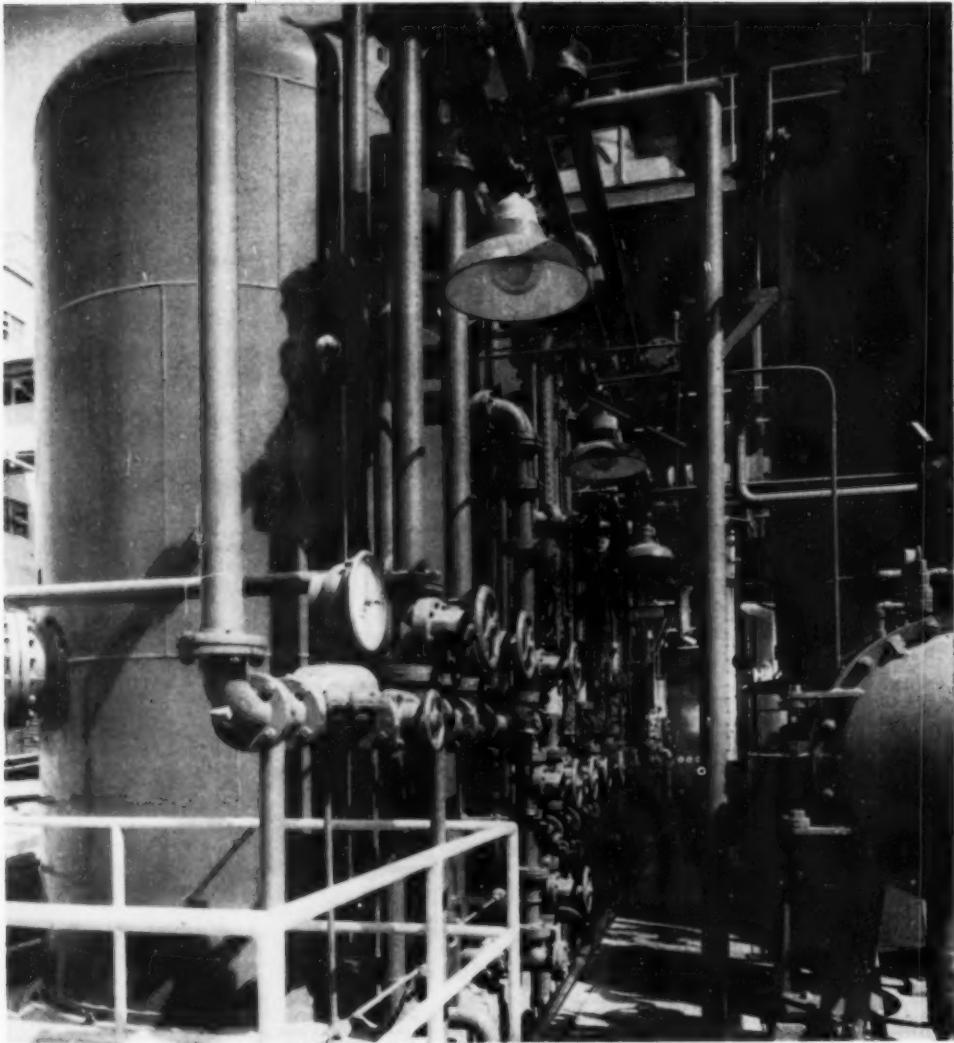
Beckman provides the industry's most complete line of glass electrodes for use with Beckman pH instruments—a type of electrode assembly to meet every industrial, research, laboratory and field requirement!



That there are so many money-saving applications for Beckman pH control that you may be losing important profits unless you make a complete investigation of your operations?

There is pH wherever there's water, water solutions, moist pastes, sludges, slurries or other moisture-containing substances. And wherever there is pH, chances are the operation can be done better . . . with greater uniformity and less waste at lower overall cost . . . by Beckman-controlling the pH of the various processing operations.





New Units Deionize Glycerine

Ion exchange muscles in on distillation in glycerine refining. Method works on soap-lye crude and sweetwaters, removes salt and color bodies, requires no heat.

Ion exchange, ever versatile, has still another new job. It's being used instead of distillation to purify crude glycerine.

What's more, it works equally well on different kinds of crude. Three plants now employ a new ion exchange

process developed by Illinois Water Treatment Co. to turn out pure glycerine. At least two others plan to do so.

► **Three New Deionizers** — The first commercial unit for purifying soap-lye crude by ion exchange is at the Los

Angeles plant of Lever Brothers. It handles 26,600 lb. of crude per day.

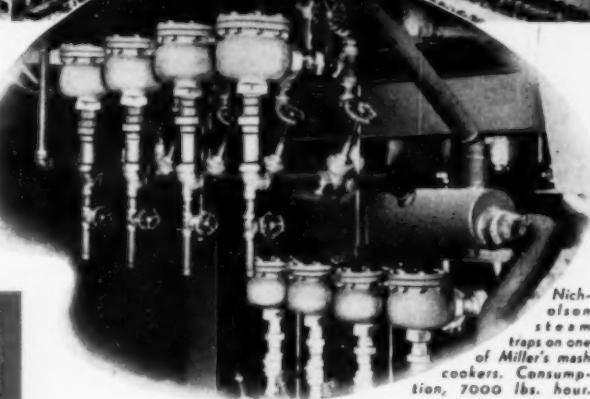
At the Wyandotte, Mich., plant of Archer-Daniels-Midland Co., another deionizing unit purifies 15,000 to 16,000 gal. of dilute glycerine sweetwater in a 24-hr. cycle. The sweetwater comes from the high-pressure hydrolysis of fats, and contains about 10 percent glycerine.

The third unit is at the Los Angeles plant of Vegetable Oil Products Co. It deionizes 5,000 to 9,000 gal. of Twitchell sweetwater per cycle, producing USP and even reagent grade glycerine. (Continued)

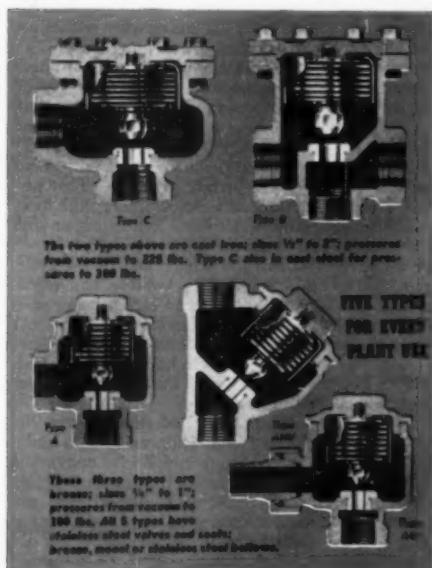
NICHOLSON TRAPS SELECTED for New Miller Brewery



A giant \$25,000,000 building program, which started in 1945, has made this Milwaukee home of nearly century-old Miller High Life beer one of the most scientifically advanced breweries in the nation. Dominated by the towering 200-foot high brew house, this vast 28-acre



Nicholson steam traps on one of Miller's mash cookers. Consumption, 7000 lbs. hour.



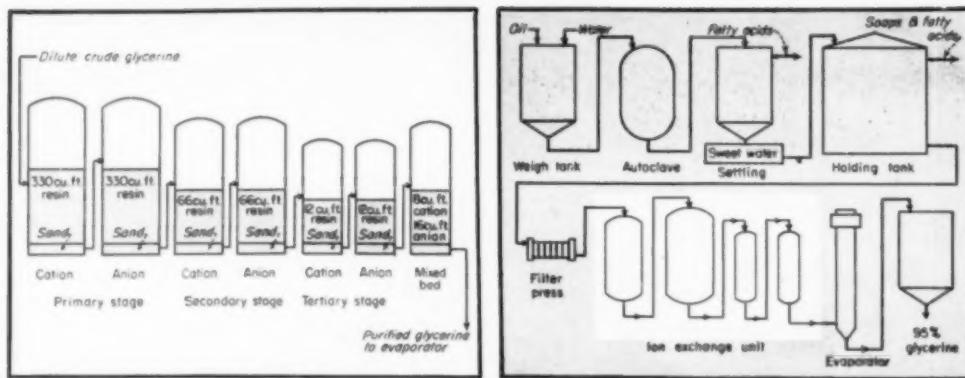
plant has a daily capacity in excess of 4,000,000 bottles and cans. Miller has adopted Nicholson thermostatic steam traps almost 100%. It is significant that this outstanding brewing firm, like many leaders in the other processing industries of the nation, has chosen Nicholson traps. To see why leading plants are increasingly standardizing on Nicholson steam traps for positive drainage and faster heat transfer . . .

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Installation diagrams
and data for determining
proper size of trap.*

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DEIONIZER at Lever's plant handles soap-lye crude, while ADM's unit gets sweetwater from continuous fat-splitting autoclave.

► What Process Does—The ion exchange process, according to A. C. Reents, research director of Illinois Water Treatment, removes dissolved salts, acids and bases, as well as odor and color bodies, without use of heat. It can be used on different kinds of crude glycerine solutions.

Glycerine solution, anywhere from very dilute to 40 percent by weight, passes through a series of pressure vessels containing ion exchange resins. After deionization, dilute glycerine is concentrated by vacuum evaporation. **► When Deionizing Pays**—Economics alone determines whether distillation or deionization is the best way to get pure glycerine, according to Reents. The two costs to watch are original investment and operating costs.

For soap-lye crude, the original investment for deionization is cheaper than for distillation. Operating costs are about the same. But, as Reents further points out, deionization gives a greater yield, as no dynamite grade or foots are produced. "Thus the process," says Reents, "is ideal for a new plant, or for replacement of worn-out or inefficient stills."

For Twitchell sweetwater or sweetwater from a continuous fat splitter, the process is exceptionally well adapted. The dilute glycerine is deionized and evaporated to yield the pure product. No intermediate product, saponification crude, must be made before purification. Operating costs are quite low for these types of glycerine solutions, as the contaminant level is much lower than with soap-lye crude.

► Costs—Chemicals for regeneration and the resin amortization constitute the main operating costs. Chemicals consumed are best considered as pounds of sulphuric acid and sodium hydroxide per pound of 95 percent pure glycerine obtained, since their

cost varies from plant to plant. Resin amortization is computed as cents per pound of 95 percent glycerine. Here's how Reents breaks down these costs for soap-lye crude and two kinds of sweetwater:

Source and Glycerine Content	H ₂ SO ₄	NaOH, 68° Be.	Technical Resin
Soap-lye crude, 80%	0.22 lb.	0.13 lb.	1.20¢
Twitchell sweetwater, 9.5%	0.17 lb.	0.12 lb.	0.80¢
Emery-Colgate sweetwater, 10%	0.08 lb.	0.04 lb.	0.30¢

► Purifying Soap-Lye Crude—At Lever's plant in Los Angeles, the ion exchange unit replaces only the stills in the conventional process for manufacturing glycerine from soap lyes. Ion exchange is carried out on dilute crude glycerine prepared by lye treatment and evaporation. Lye treatment removes the bulk of fatty materials, and evaporation gets rid of much of the salt. These two steps cannot be handled economically at present by ion exchange.

Lever's ion exchanger is a four-stage unit (see cut). Enough ion exchange capacity has been built into the system to yield the equivalent of CP glycerine by using only the first three stages. The final mixed bed was added as a "polishing" step to give a better product than produced by distillation.

The ion exchange vessels, lines and valves are rubber-lined, and all auxiliary equipment is made of corrosion-resistant material.

In operation, reports G. W. Busby of Lever's research and development division, 26,600 lb. of 82 percent crude glycerine is handled per day in two 12-hr. cycles. Each 13,300-lb. batch of crude is diluted to about 25 percent glycerine, filtered through a leaf filter, and pumped into the primary unit.

Since the resin beds are kept

flooded with water, some dilution takes place as the glycerine solution displaces the water. This dilution is known as "sweetening on," a term borrowed from the sugar industry. Dilute crude is pumped in at 20 gpm. until the entire batch is in the unit.

Sodium chloride is the principal impurity. Sodium ions are held by the cation-exchange resins, and the chloride ions combine with the anion-exchange resins. Each pair of cation-anion exchangers removes 80-85 percent of the total ions in solution. Some of the resins adsorb non-ionized color and odor bodies from solution.

Glycerine solution is removed from the unit by displacement with water, city water being used to force the glycerine through each of the ion-exchange vessels. This step also dilutes part of the glycerine solution and is called "sweetening off."

Deionized glycerine solution from "sweetening on" and "sweetening off" that contains less than 15 percent glycerine is run back into a tank and used to dilute the next batch of crude. Deionized product runs usually about 20 to 30 percent glycerine. That percentage increases as more and more of the water from sweetening on and off is used.

After the service part of the cycle, the resins are backwashed and regenerated, 12 percent H₂SO₄ being used for the cation resins and 5 percent NaOH for the anion resins. Acid and alkali are rinsed from the resin beds with water, and the unit is ready for the next cycle.

Dilute deionized effluent from the unit is stored temporarily in a stainless steel tank and finally evaporated under vacuum to the required specific gravity. The final product does not require filtering or bleaching. It compares favorably with a high-grade distilled glycerine.

(Continued)

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within pressure systems**



The **heart** of a BS&B Safety Head is the rupture disc...and it provides the only kind of "heart-failure" that means life and continued healthy operation. The safety disc's "heart-failure" is the controlled weakness BS&B built into it for your protection - for the safety of your personnel, your property, and your valuable equipment.

You give us the necessary operating information. BS&B will give you a safety head—with a heart—that will always fail safe—within plus or minus 5% of the pre-determined pressure specifications for safety. This we can guarantee; for discs are rated and checked by actual rupture tests. First, the metal is selected for fabrication to specifications of any given lot of discs. Then discs are selected at random, and tested to destruction after the lot is completed. If each one tested does not break within 5% of the rated pressure the entire lot is discarded.

Never be too sure about safety. **WRITE TODAY** for complete BS&B Safety Head Catalog and complete details. There is no charge or obligation for a complete analysis of your pressure safety requirements.

SAFETY
HEADS

BS&B

HEADS



To the many industries requiring pressure vessels and accessories, BS&B is well known for its research and fabrication in this field. For example, we have solved the behavior problems of metals where safety head discs are concerned. In the BS&B plant you'll find the largest selection of thin ductile metals in the world ever assembled in one place. This enables us to fabricate over 95% of all rupture disc orders from materials on hand.

BS&B Safety Heads can be used for primary relief wherever maximum protection is required ... or for secondary relief to back up a relief valve whenever the contents of a vessel or system may prevent the valve from functioning properly. It provides full pipe-sized unrestricted opening. Rupture discs are available within a range of 5 lbs. to 40,000 lbs. The fail-safe action of BS&B Safety Heads is fast, positive, accurate . . . whether your pressure applications are for air, gas or liquids—bland or corrosive. They're code-accepted.

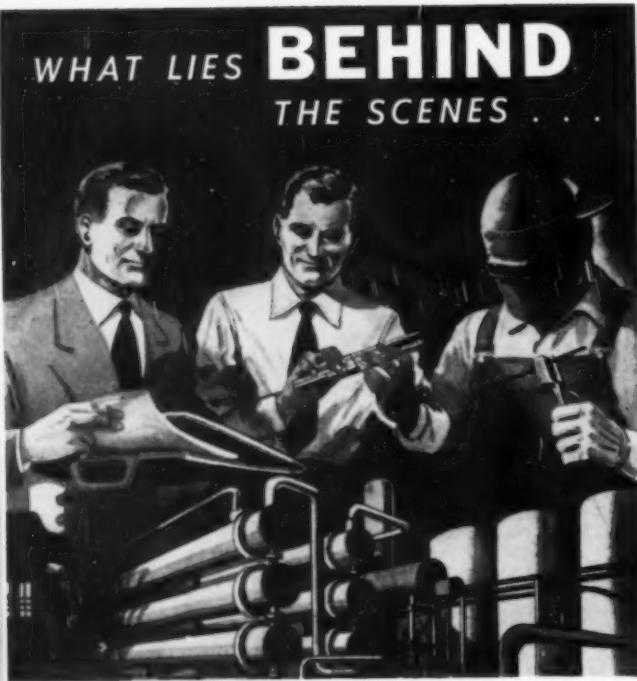


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All Western Heat Exchange Equipment fabricated to strict TEMA or ASME standards.



NEWS, cont. . .

► **Crude From Fat Splitter**—The deionizer at the Wyandotte plant of Archer-Daniels-Midland is much smaller and handles an entirely different kind of crude. It purifies dilute sweetwater, containing about 10 percent glycerine, that is relatively free of impurities because it comes from the high-pressure hydrolysis of fats. Compared to soap-lye crude, it has a far lower content of ionizable solids.

The essential operation is the same, however, except that ADM's equipment works on a more or less continuous principle until the resin beds become spent.

There are a few things to watch out for. All fatty acids and oils, for one thing, have to be kept out of the resin beds to prevent fouling. Another thing is that the resins are heat-sensitive, and should be used with sweetwaters below 95 deg. F.

Sweetwater is pumped to a large settling or holding tank. It can hold enough to last 15 days, giving ample settling time with two turnovers a month in the tank. The stay in the tank does two things: (1) any metallic soaps formed during the hydrolysis, together with fatty acids that inadvertently get into the sweetwater, are settled out; and (2) the sweetwater is cooled. It goes into the tank at about 180 deg. F., and leaves the bottom at less than 95 deg. F. even in summer.

As a precaution, sweetwater is first filtered and then goes through ion exchange equipment similar to that in Lever's plant, but much smaller. ADM's primary cation exchanger holds 78 cu. ft. of resin, the primary anion exchanger holds 103 cu. ft., and the final two each have a resin capacity of 15 cu. ft.

It takes 13 to 15 hr. to run through 15,000 to 16,000 gal. of sweetwater, according to W. F. Rahles of Archer-Daniels-Midland. A complete cycle takes about 24 hr., including time for regeneration, sweetening on and sweetening off.

In small equipment like this, Rahles points out, great care is required to keep efficiency high, by careful regeneration, to minimize the dilution due to sweetening on. This is a factor that refiners don't have to contend with in deionizing soap-lye crude. Most of the dilution due to sweetening on, at the ADM plant, is over when the first 3,000 gal. have been run in.

Dilute deionized glycerine is concentrated by vacuum evaporation. ADM gets glycerine of 95 percent purity by this process. It's of good color and, in fact, some CP grade has been produced on occasion.

The Wyandotte plant handles all types of oils, most of them not the best stocks. It also handles considerable foots. Rahles has figured some costs on the operation, and they agree pretty closely with those of Illinois Water Treatment for deionizing sweetwater from a continuous fat splitter. Rahles estimates that ADM's costs for resins and chemicals vary between 0.30 and 0.50 c. per lb. of product.

► **Twitchell Sweetwater**—Last of the trio of new deionizing units is at the Los Angeles plant of Vegetable Oil Products Co. It is successfully purifying a filtered Twitchell sweetwater. The deionized solution is evaporated in an iron evaporator. Some bleaching is necessary to remove any color picked up in the evaporator. The product is USP and, in some cases, reagent grade glycerine.

This deionizer consists of primary, secondary and mixed-bed units. It is similar in design to the Archer-Daniels-Midland unit, with the exception of the fact that it has an additional mixed bed.

The unit treats, depending on the type of sweetwater, anywhere from 5,000 to 9,000 gal. per cycle in a manner similar to the Archer-Daniels-Midland unit. One man handles the ion exchange operation and the evaporation.

After completing over 200 cycles, the unit of Vegetable Oil Products had sustained no apparent capacity loss. And, according to D. M. Stromquist of Illinois Water Treatment, cost figures indicate that once a unit exceeds 200 cycles it is well within the economic limits on resin amortization.

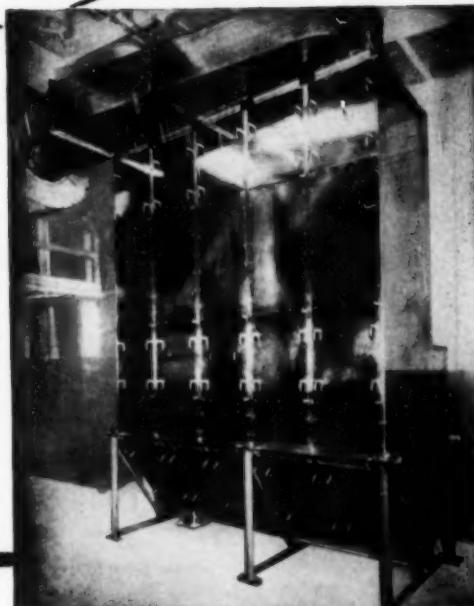
► **Upgrading to CP**—Illinois Water Treatment is trying constantly to adapt ion exchange to the purification of all types of impure glycerine solutions. Its latest wrinkle is prompted by the current demand for CP glycerine.

What IWT is doing is upgrading high-gravity and single-distilled glycerine to CP. The company has successfully done this, using a single tank deionizer. First, high-gravity glycerine is diluted to 50 or 60 percent by weight with water. This reduces the viscosity so that the glycerine will pass through the ion exchange resin. Purification is effected by passage through a mixed-bed deionizer, containing a mixture of regenerated cation and anion resins in a single bed.

This single-stage deionization, followed by evaporation, produces CP or USP glycerine with a very low ash content — below 0.005 percent. Whether it's of interest to industry is something Illinois Water Treatment is busy finding out.

\$ave \$ out of DU\$T

**SAVE
DOLLARS
OUT OF
DUST**
In Processing of
FERTILIZERS
PLASTICS
DRUGS &
COSMETICS
FOOD MATERIALS
& OTHER
PRODUCTS

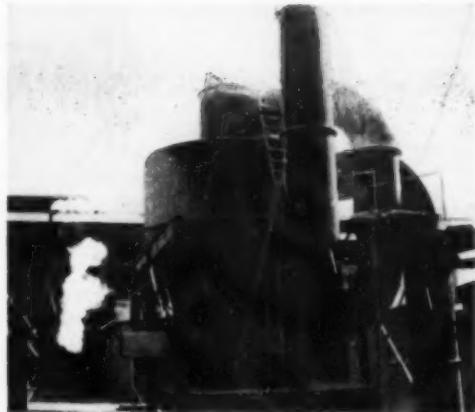
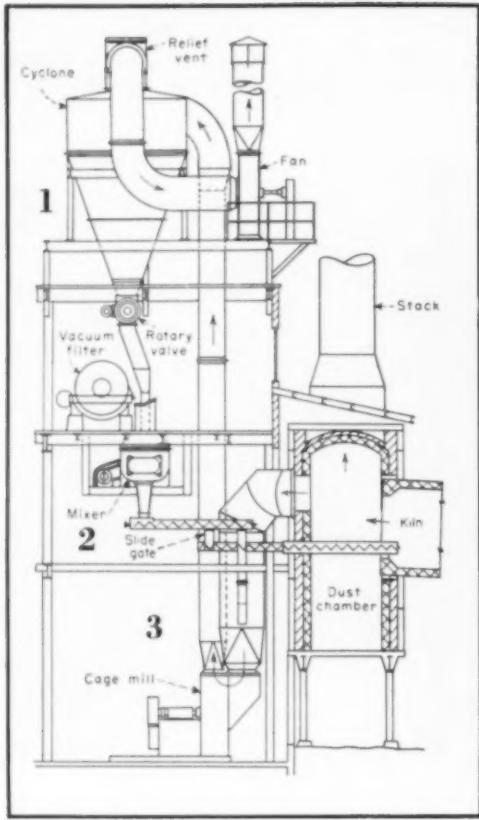


The Simon Suction Filter Dust Collector
U. S. Design and Manufacture by
ENTOLETER DIVISION

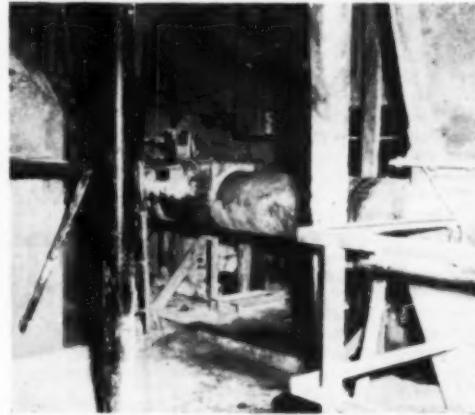
Dust problems are effectively solved with the Simon Suction Filter Dust Collector. This self-contained, all-metal unit needs no accessory equipment except a fan and connecting ducts. Dust is collected at practically 100% efficiency, permitting air to be blown out of the chemical plant without costly loss of materials, or into the building without risk of dusty atmosphere. Cleaned air from collector can be returned to plants to save heat in winter, and blown outside in summer to control humidity. Streamlined ALL METAL design with minimum ledges and dead spots. Minimum maintenance cost. Low power — 1-HP to operate 12-section unit. Operates under suction, eliminating dust leaks. Send for complete information. ENTOLETER DIVISION, The Safety Car Heating and Lighting Co., Inc., 1197 Dixwell Ave., New Haven 4, Connecticut.

ENTOLETER

CENTRIFUGAL MACHINES



1 Ducts connect cyclone to cage mill. Dried carbonate travels up to cyclone, is separated out, sent to mixer.



2 Screw conveyor moves the material over adjustable slide gate which controls amount of damp material to kiln feed.

Flash Drying Aids A Rotary Kiln

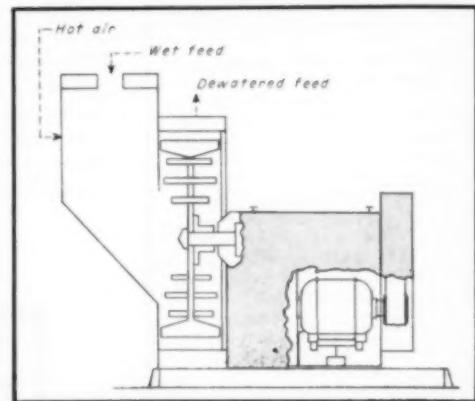
Gives a boost to a rotary kiln for reburning lime kiln mud in a kraft pulp mill. Commercial unit has been operating for a year. At least three more are in the works.

The first commercial installation of a unique* use of flash drying equipment has now proved itself at the Chesapeake Corp. of Virginia at West Point, Va.

The company uses flash drying of calcium carbonate to increase capacity of an existing rotary kiln in a pulp mill. Essentially, the rotary kiln now performs the one job of calcining instead of the previous drying, followed by calcining. The basic operation is the recovery of quicklime from calcium carbonate sludge.

With this flash drying setup, the lime-burning capacity of the kiln has increased by 40 percent, fuel consumption

*For another recent "first" in flash drying—this time for corn starch—see *Chem. Eng.*, March 1952, p. 248.



3 Cage mill with special rotor provides maximum agitation so that stream of hot air instantaneously removes moisture.



FOR TOUGH TONNAGE

Homocord **CONVEYOR BELT**

"We pay more for Homocord, but it costs us less!" • That's what users say . . . and they won't take any other conveyor belt. It makes sense, too. Where tonnage is toughest, Homocord has been known to outlast 2 or 3 ordinary conveyor belts. Figure cost of belts, plus cost of repeated installations, and Homocord proves the biggest bargain you can get • Its special construction—cushioned and flexible—absorbs impact that other belts can't take. Send for Bulletin 6906 and read about the Guillotine Test that proves our point • The same engineering goes into our hose, V-belts and flat belts. Get your Manhattan representative to show you.



MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS - MANHATTAN, INC.



Flat Belts



V-Belts



Conveyor Belts



Hose



Roll Covering



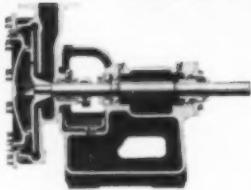
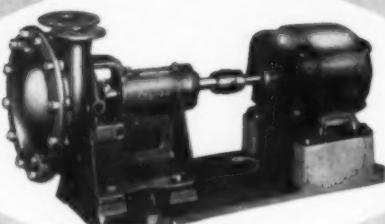
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Abrasive Wheels

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Packings • Brake Linings • Brake Blocks
Clutch Facings • Asbestos Textiles • Sintered Metal Parts • Bowling Balls

For economy in handling corrosive liquids . . .



With the stuffing box on suction side of impeller, pressure on it is limited to the suction head only, assuring long packing life and freedom from excessive leakage. Interior of pump can be inspected and cleaned and impeller can be removed or replaced without disturbing the piping.

**Other GOULDS PUMPS
for processing plants**



This highly efficient Goulds single stage centrifugal pump (Fig. 3109) is well suited for general processing purposes. Ten sizes.



Nonclogging impeller of this vertical sump pump (3047) will handle water containing large solids or fibrous materials.



For capacities up to 15,000 g.p.m. heads up to 30 ft. Check the specifications of this Goulds half bearing double suction centrifugal (3450).

**specify
GOULDS
stainless steel
centrifugal
PUMPS**

One plant engineer reports better than a seventy-five percent cost saving by handling an especially erosive slurry with Goulds Fig. 3705 Stainless Steel pumps. The pumps previously used not only cost almost four times as much as the Goulds pumps, but the Goulds pumps have already been in service over twice as long.

The entire fluid end of this Goulds Fig. 3705 pump is of stainless steel mounted on a cast iron support. It is regularly carried in stock in No. 316 and FA 20 stainless steels, but other metals and alloys can be supplied for all parts coming in contact with the liquid.

This pump has several features that contribute to economical, 24-hour service with acid and alkaline liquors which quickly corrode standard iron or bronze pumps. Bulletin 725.3 describes this Goulds unit in detail. We will be glad to send you a copy.



PUMPS INC.

*Seneca Falls
New York*

News, conf. . .

has been cut by 38 percent, and make-up lime is reduced 37 percent.

The unit at Chesapeake has been operating successfully for a year now.

Actually, the principle of flash drying has been used for a long time in many industries, but its successful use on lime kiln sludge indicates an even further extrapolation—on the wet cement process or certain types of ore slurries, for instance.

According to Robert D. Nickerson, of Combustion Engineering-Superheater, Inc., New York, here's how the equipment at Chesapeake works:

Flash drying, of course, means the almost instantaneous removal of moisture by heat in a turbulent stream of hot air. Instantaneous drying means maximum agitation. A cage mill, consisting of a special rotor enclosed in a housing, does the trick. The wet material and the hot gases are brought into intimate contact and the water vapor blanket on each particle is continuously removed by agitation.

Here's how the material and gases flow through the system:

A vacuum filter discharges its mud to the mixer (see cut) where it is blended with all of the dried carbonate discharged from the flash drying system. From the mixer, a screw conveyor moves the material over an adjustable slide gate through which the proper proportion of damp material drops to the kiln feed screw. The remainder goes to a chute, then to a cage mill (see cut). Here the drying is done by the cage mill agitating the carbonate in hot gases from the kiln.

Both the gases and the carbonate are carried upward from the cage mill through the duct work to the cyclone. Here, the now-dried carbonate is separated out by centrifugal action and discharged to the mixer.

Spent drying gases are drawn from the cyclone by the vent fan and discharged to atmosphere or through a secondary dust collector.

This fan was selected to allow the use of a secondary dust collector if necessary or desirable. Operating experience at Chesapeake indicates that the secondary collector is desirable. The newer installations will be equipped with secondary collectors and Chesapeake Corp. is installing one.

► **Performance Is Tops**—Present re-burning capacity of the Chesapeake installation is 80 tons per day (had been 57 tons) without allowance for downtime. The slash in lime make-up (from 106 to 67 lb. CaO per air-dry ton of pulp) is principally due to the increased reburning capacity of the kiln.

Operating results indicate that the present make-up of 67 lb. can be cut still more by (1) the use of a second-

ary dust collector for the flash dryer and the present bypass stack and (2) by improvements to the original caustic equipment.

► **Maintenance Is Easy**—Inspection of the dryer after 6 mo. of continuous operation showed excellent condition of machinery items. The one exception was in the duct where abrasion had worn three points. These points, originally constructed of mild steel, will be replaced with more resistant materials.

► **Operation No Problem**—No additional personnel are needed to operate the added equipment because the caustic operators can easily supervise the dryer. No difficulty has resulted from starting or stopping the drying operation.

The vacuum filter (see cut) averages 30 to 35 percent moisture in the mud feed to the flash dryer. Before the dryer was installed, the vacuum filter cake averaged 40 to 45 percent moisture. The flash dried product contains about 1 percent moisture.

Vent temperature from the flash dryer is 150 deg. F. This is controlled automatically by regulating the temperature of the hot waste gases from the kiln. Amount and temperature of these gases depend on the evaporative load at any particular time. Hot gases not used are bypassed and provide a good margin in case the oil consumption, now needed for calcining, is reduced. The calcining operation, alone, now dictates the amount of fuel burned.

CONVENTION CALENDAR

Instrumentation for the Process Industries, 7th annual symposium, Agricultural & Mechanical College of Texas, College Station, June 2-4.

Chemical Institute of Canada, annual conference and exhibition, Mount Royal Hotel, Montreal, June 2-4.

Chemical Specialties Manufacturers Association, midyear meeting, Copley-Plaza Hotel, Boston, June 8-10.

Third Annual Conference on Industrial Research, design of research operations, Columbia University, New York, June 9-13.

Drug, Chemical & Allied Trades Section, New York Board of Trade, spring meeting, Hotel Astor, New York, June 11.

National Fertilizer Association, annual meeting, Greenbrier Hotel, White Sulphur Springs, W. Va., June 16-18.

Manufacturing Chemists Association, joint meeting with SOCMA, Greenbrier Hotel, White Sulphur Springs, W. Va., June 23-25.

Synthetic Organic Chemical Manufacturers Association, joint meeting with MCA, Greenbrier Hotel, White Sulphur Springs, W. Va., June 23-25.



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• That's the best way to describe R-P&C Bar Stock Valves. These fine throttling valves provide precise, positive flow control. Long, low-cost, trouble-free service makes them ideal for meter, gauge, test, and general purpose use. Precision turned...from carefully tested metals...and suitable for a wide range of pressures and temperatures.

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valves



Wollastonite: New Mineral Wins Process Uses

First production of wollastonite—a calcium metasilicate—stirs up keen interest among producers of paints, ceramics, plastics. Output target: 60,000 tons a year.

It's news when a company, in the business of carbon black manufacture for 70 years, decides to enter the mineral field for the first time by introducing a snow-white raw material that's never before been produced in commercial quantities.

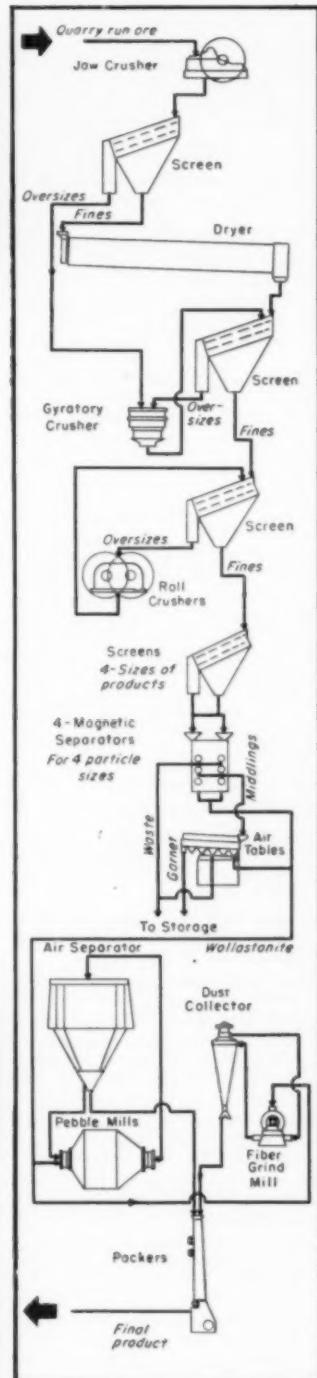
The company is Godfrey L. Cabot, Inc., world's largest manufacturer of the blackest pigment known—carbon black. The new division is Cabot Minerals, a part of Cabot Carbon Co., a subsidiary of Godfrey L. Cabot, Inc. The product is one of the whitest materials known to industry—wollastonite.

Wollastonite, a calcium metasilicate mineral, is exceptional on many counts. It has remarkably brilliant whiteness, physical and chemical uniformity and unique fibrous structure.

Its qualities make it a natural for use in many chemical process industries. ► **Plenty of It** — Besides, Cabot has plenty of wollastonite reserves. Its deposit at Willsboro, N. Y., contains about 15,000,000 tons in a seam 30-70 ft. wide, at least 100 ft. deep and over 2.5 mi. long. At Cabot's hoped-for-production rate of 60,000 tons a year, the deposit should last for at least 250 years.

Cabot's new project, when completed, will represent an investment of close to \$2 million. One mill was recently completed and is now turning out four commercial grades—one for the paint trade, one for the ceramics industry, and two fiber grinds (see cut below).

The second mill—which will be within a mile of the first—will swing



To find the one tube steel that's best for you... Ask the experts!

This month's report is on:

SICROMO 2

Has outstanding surface and structural stability at 1200°F. Has better oxidation and corrosion resistance than 2% Cr.-Mo. steel. Recommended for service up to 1200°F. as tubes in cracking coils, reforming units, heat exchangers, vapor line and hot oil piping. Also as return-bend forgings for oil heaters.

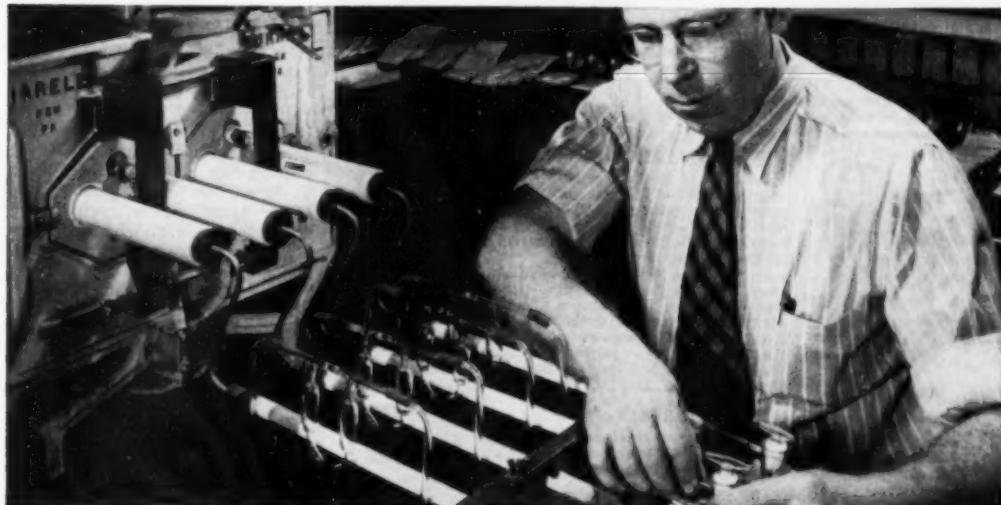
23 TIMKEN® STEELS FOR HIGH TEMPERATURE SERVICE			
Carbon	Sicromo 2	Sicromo 5S	16-13-3
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-12
Silmo	Sicromo 9	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cr	

*Not available as seamless tubing at the present time.

THERE may be several high temperature steels that will solve your temperature, pressure, corrosion and oxidation problems. But there's only one steel that's *best* for you from the standpoint of maximum tube life per dollar—the best life/cost ratio.

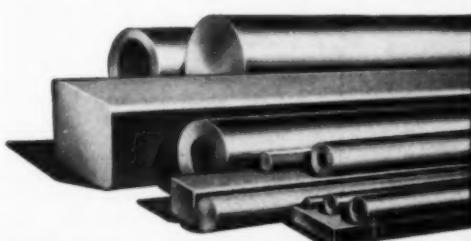
The best way to find this steel is by getting help from the Timken Company metallurgists. They're the recognized authorities on high temperature steels, backed by over 20 years of steel research and experience. And with 23 different analyses to choose from, plus wide field experience, they are qualified to help you choose the correct analysis for your application. Whatever analysis is recommended, you can be sure of uniform quality because the Timken Company rigidly controls quality from the melt shop through final inspection.

Timken's RSQ—Research, Supply, Quality—can solve your tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



Extensive testing is one reason for Timken's leadership in high temperature steels. Photo above shows carbon determination test.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

CHEMICAL ENGINEERING—May 1952

IT'S HERE!

New Bottom Unloading Carrier Cuts Centrifuging Time, Labor and Costs

Originally designed for the impregnation of insulating materials, this special AT&M carrier — featuring exceptionally fast, easy unloading — offers new advantages to many processes.

It is incorporated in a link-suspended type AT&M centrifugal, in which a specially designed link guarantees minimum vibration in the foundation, uniform load distribution on the links and smooth operation with "out-of-balance" loads. Optional features include: fume-tight covers for volatile liquids, spray pipes, exhauster connections or removable baskets. Drives are direct-connected or clutch-operated. Speed lock prevents opening of cover until machine is at full stop.

(A) The new AT&M carrier, illustrated, is loaded conventionally, through the top. (B) Unloading is effected through a six-segment trap door in the bottom, eliminating all handling or tipping, reducing the time and trouble of unloading to a minimum, and enabling more cycles per shift.



Another AT&M Advanced Feature

Designed to provide a perfectly controlled, fixed speed essential to the unloading of sticky sludge and many other materials, AT&M's two-motor, free-wheeling drive combines positive operation with maximum safety. Built-in oiling system requires no pumps, or check valves.

You, too, can benefit with AT&M equipment. Does away, in many instances, with settling tanks, filter presses, squeeze rolls, vacuum presses. Used in processes involving chemical preparations — explosives — nitrating — acid wringing — ammonium sulphate — oils and greases — paints, varnishes — ceramics, bricks, clay — fertilizers — nitrates — sludges — textiles — carbonizing (textiles) — plastic bases.

PROVE TO YOURSELF

How centrifuging can benefit you. Send us a sample of your material for centrifuging to your specifications, or rent an AT&M laboratory centrifugal for your own tests at a nominal fee. And send for free booklet today.



AMERICAN TOOL AND MACHINE COMPANY
1415 Hyde Park Avenue, Boston 36, Mass.

Please send me my free copy of the new AT&M booklet "Centrifugal Force." I am interested in the following processes:

Separation Extraction Dehydration Clarification Coating Filtration
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SAVE TIME,
SPACE AND
COSTS WITH

A.T. and M.
CENTRIFUGING

NEWS, cont. . .

into operation early next year. It is being engineered by Charles T. Main, Inc., a Boston firm.

► **Simple to Process**—Actual processing of the ore is simple (see flow diagram). Principal unit operations are size reduction and solids separation.

Ore first goes through a large jaw crusher and rotary dryer, then through a series of roll crushers; these grind it to pass a 16-mesh screen. The thin, needle-like crystals of wollastonite are easy to crush and grind.

Ground ore is screened into four size fractions, then goes to air tables and magnetic separators which take out the garnet. Some customers use the pure white wollastonite in this form; most require a finer grinding in roll crushers and Hardinge conical pebble mills. These are arranged with screens and air classifiers to give any required fineness.

In special fiber grinds, the fiber length may be 13-15 times the diameter. Short fiber particles can also be turned out. For use in paints and ceramics, regular grinds are now made to 96.95 percent through 325 mesh.

Wollastonite as mined contains about 15 percent andradite garnet and a small amount of green diopside. Both are easily removed by either gravity or magnetic separation.

Byproduct garnet has possibilities in the abrasive field. In finer grinds, Cabot garnet may compete in the metal and glass grinding industries.

Since wollastonite is easy to mine and simple to process, Cabot says its product will cost no more than any other mineral in the filler price range. Right now, it's already the only white, wholly fibrous mineral in that particular range.

► **Already in Ceramics**—That it's going to be an important material in the ceramics field is already apparent.

Up to now, some of the best ceramic electrical insulators have been made from old, long-established minerals—feldspar, flint, clay and talc. The best of these insulators, made of talc, have a dielectric strength of 240 v. per mil. Wollastonite insulators have a dielectric strength of close to 350 v. per mil.

Interest has been shown in the use of wollastonite for ultra-low loss ceramic insulators for defense equipment. Here it would probably replace steatite talc which was in such limited supply during World War II.

Government tests have shown that the loss factor (the measure of power loss) of wollastonite-based insulators in an electrical condenser is far lower than that of the conventional type, being on the order of 0.3-0.4 percent. This is 50-60 percent less than the

best low-loss ceramic insulators now produced commercially.

Wollastonite looks equally good in ceramic tiles. In addition to being a match for the present types of tile, wollastonite can be produced in a one-fire process at temperatures 150-200 deg. lower. This saves the manufacturer some 40 percent of his fuel cost and allows a greater production rate from the same number of kilns. What's more, this could open up possibilities for new firing methods.

Several leading firms are now testing wollastonite in glazes for sanitary ware. One large firm is already using it for glazes; another is using it as a substitute for lime and silica in producing frits for metalware enamels. Here wollastonite is cheaper than the pre-fritting of limestone and silica, the normal way of introducing calcium silicate. Wollastonite acts as a natural frit.

Under investigation too, is the use of wollastonite as a substitute for limestone and flint in the preparation of all types of glazes, and in bodies and glazes for whitewares and electrical porcelain. Wollastonite is used to strengthen bodies; it makes them less prone to break and chip.

► **For Paints, Too**—The paint industry is eyeing the new mineral as an extender for all types of paints. All paint extenders absorb oil, but wollastonite far less than others.

Using a wollastonite extender, it takes only 26 lb. of oil to carry 100 lb. of pigment; this can amount to as much as an 11-lb. saving of oil. Besides absorbing less oil, wollastonite extenders have proved to hold pigments at lighter, less viscous consistency than conventional extenders.

Some of the country's leading paint manufacturers have made comparative exposure tests with outside paint. Over a period of several years they have found that wollastonite panels were brighter, showed less dirt and clearer tints, gave better resistance to mildew. Wollastonite is more wettable in water than conventional extenders. It is also compatible with latex, which should make it popular in latex-base paints as well.

► **Other Uses**—Wollastonite is also being considered for use in welding rod coatings, alloying agents, silica gel, and a paper coating pigment. Its fibrous structure may well make it useful as a reinforcing fiber in plastics, cements, wall board and other process industry products.

Cabot's people are convinced that wollastonite's possibilities in industry have hardly been scratched. Meanwhile, the company is pushing ahead with its intensive research and development program to turn up brand new markets.

Here's the most efficient

NITROGEN GENERATOR ever built!



FOOD PACKAGING, CHEMICAL, REFINING, METALLURGICAL — wherever Nitrogen atmospheres are required — you'll find Gas Atmosphere Nitrogen Generators delivering greater efficiency at lower costs.

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The Gas Atmosphere Nitrogen Generator has maximum flexibility — impartial laboratory analysis shows 99.9 per cent Nitrogen, or up to 10 per cent combustibles in Nitrogen can be continuously maintained. Many other exclusive features make the G-A Generator the best, most efficient generator ever built.



ORIGINAL G-A DESIGN COMBUSTION CHAMBER — Reboiling method of reactivation of CO₂ absorbing solution first adapted to nitrogen generators by Gas Atmospheres, Inc. Of compact design this method assures highest efficiency — most economical operation.

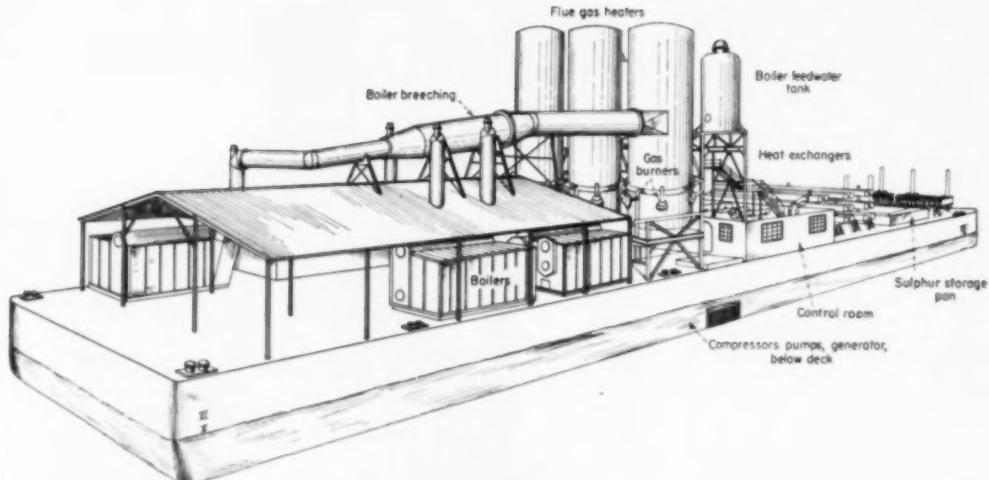
For more complete information write for Bulletin number N-432

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Frasch Plant Goes Amphibious

This year Freeport Sulphur starts up its amphibious operation in the Louisiana marshes. New in sulphur mining, it hinges on unique salt water treating process.

A new kind of sulphur mining will get under way late this year when Freeport Sulphur Co. starts up its plant at Bay Ste. Elaine.

The operation, located in the Louisiana salt water marshes, will be unusual in many respects. The Frasch injection plant will be mounted on a barge; canals will take the place of roads; boats will be used instead of trucks; pipe lines will be supported on piling bents; molten sulphur will be barged 75 miles to storage at Port Sulphur.

One unique feature at Bay Ste. Elaine will be the use of hot brackish marsh water (the only source of fresh water is 35 mi. away) for well injection.

Salt water has never been used before since it corrodes equipment and scales boilers and hot water lines. Freeport engineers found the answer by working out a system to heat and decarbonate brackish water so that it no longer gives these troubles.

► **No Cinch**—But look at it anyway you please, the Frasch mining of sul-

phur in a salt water marsh is no easy job*.

Prospecting, for example, was tough and expensive. To do the drilling job, Freeport built two barges capable of drilling down to 3,000 ft. Each barge (below) cost \$250,000.

A specially designed steel mining barge (above) had to be built. This summer, when the barge will be completed, it will be towed 65 miles to Bay Ste. Elaine, sunk on a prepared bottom and put into production.

This barge will furnish some 1,750,000 gal. of hot water (at 325 deg. F.) per day for the mining operation. It will also supply 400 cfm. of air at 500 psig., a power load of 600 kw.

* A full account of Freeport's marsh operations was recently given by Z. W. Barlett, C. O. Lee and R. H. Feierabend before the annual meeting of the American Institute of Mining and Metallurgical Engineers in New York.



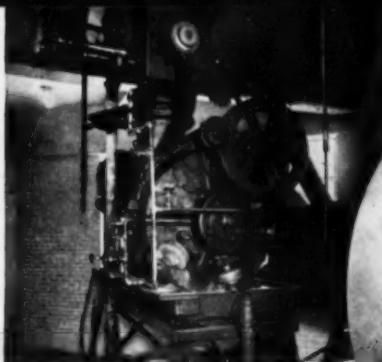
ENGINEERS stake out location for a canal.



FLOATING drilling rig sinks a new sulphur well.



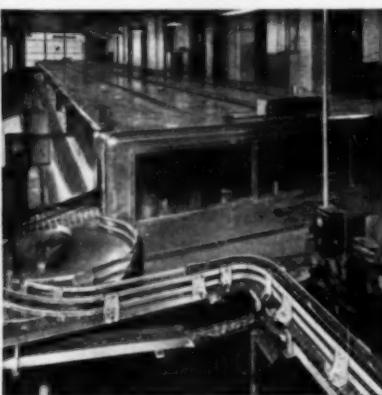
Keg scrubber—A constant stream of water at 130° F. plays over these barrels and reaches bearings on conveyor.



Wet-grain press—After being heated to 180° F., grain is then pressed dry. Hot water comes in contact with bearings.



Bottle soaker and washer—Bottles are first cleaned with strong alkali at 180° F., then washed with water. These conditions make bearing lubrication difficult.



Pasteurizer—Beer is pasteurized in this modern machine which is subjected to constant water spray ranging from 80° F. to 140° F.

No trouble brewing for bearings!

A midwest brewing plant employed seven different greases in a variety of applications. Despite the use of these special products, the operators experienced difficulty. The greases would not withstand both water and high temperatures. Frequent applications were necessary.

A Standard Oil lubrication specialist was called in on this problem. Upon his recommendation, STANOLITH Grease—a lithium-soap product with the ability to withstand both heat and water—was given the job.

As a result, STANOLITH has replaced all seven greases formerly used and *has done a better job in each type of application*. Through its use over a two-year period, grease consumption has been reduced 20% and time spent in applying grease cut 50%.

STANOLITH Grease can prove its remarkable versatility in your plant, too. Its high mechanical and chemical stability plus its extreme resistance to heat and water qual-

STANOLITH
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Greases

fies it to replace a variety of special greases.

To obtain maximum benefits from STANOLITH, use the services of a Standard Oil lubrication specialist. His headquarters are near your plant. How you can benefit by his on-the-spot service is explained at the right. Standard Oil Company, 910 South Michigan, Chicago 80, Illinois.

What's YOUR problem?



Mr. D. V. Wills of Standard Oil's South Bend office is the lubrication specialist who helped this Midwest brewing company solve a difficult lubrication problem.

He is one of many Standard Oil specialists located throughout the Midwest. These men have the practical experience and special training to handle lubrication problems on any type of operation.

Take advantage of the service offered by the lubrication specialist nearest your plant. You can reach him by phoning your local Standard Oil Company (Indiana) office. Why not call, today, and arrange to discuss with him the advantages offered you by STANOLITH and other outstanding products such as:

STANOIL Industrial Oils—This general-purpose line of oils provides cleaner operation of hydraulic units and supplies effective lubrication in compressors, gear cases, and circulating systems. One or two grades can replace a wide variety of specials oils and lubricants.

SUPERLA Greases—Available in a wide range of consistency grades and in both lime-soap and soda-soap types, SUPERLA Greases cover a wide range of applications. These efficient products are comparable in quality with the highest type of special greases.

STANORUST Rust Preventives—The eight grades of STANORUSTS form one of the most complete and effective lines of rust preventives on the market today. Each has been scientifically developed for its intended use. The grades range from a fingerprint remover to a heavy petrolatum that protects against corrosion for years under the most severe outdoor exposure.

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(Indiana)



Well, Doc, how long will I live?

The service life of your stainless steel processing equipment is determined by your fabricator. In the professional skill of his mechanics, welders and craftsmen lies the answer to the useful life of that equipment.

For stainless fabrication requires a specialist—with manpower trained, experienced and equipped for that work. A general practitioner might miss up on something that would impair the strength or corrosion resistance of stainless steel. The special technique required for sound welds—the right degree of heat in welding a seam, the proper finish for your application—round corner construction to allow removal of corrosive materials—these often determine how long your equipment will "live" in service.

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A request on your letter-head will bring our guide, "What to Look for in Stainless Steel for Your Processing Equipment."



News, cont. . .

and steam for heating sulphur lines and equipment. The barge will be 40 ft. wide, 200 ft. long and 12 ft. deep.

In the Frasch sulphur mining process hot water is pumped into the well, percolates through the formation and gradually heats up the mass of rock and sulphur. When the sulphur reaches 240 deg. F. it melts, flows downward to the bottom of the well and is then pumped to the surface as molten, high-purity (99.5 percent or better) sulphur.

At Bay Ste. Elaine this hot, liquid sulphur will then be loaded into one of two transport barges that will carry it 75 miles to Port Sulphur. There it will be pumped into freezing tanks to solidify.

Each transport barge can carry 1,000 long tons of liquid sulphur. Although the barges have steam coils to keep the sulphur from freezing, no heat will be applied en route because insulation will prevent heat losses from becoming too great.

► **Uses Brackish Water**—Success of the Bay Ste. Elaine operation actually hinges on the use of brackish marsh water instead of fresh water.

A new water treating process, which Freeport has worked out over the past eight years, will be used for the first time. This will enable Freeport to heat and use water with up to 28,000 ppm. of salt without having to deal with the usual problems in scaling and corrosion.

Scale deposited when sea water is heated to high temperatures is made up of two different classes: (1) deposits of calcium and magnesium as carbonates and hydroxides due to the decomposition of bicarbonates, and (2) deposits of sulphate scale due to the lowering of the solubility of calcium sulphate when the water is heated.

Freeport's approach was to develop a process that would be cheaper than the chemical removal of calcium and magnesium salts. Basically, the new process to be used at Bay Ste. Elaine consists in heating the sea water under controlled conditions which minimize decomposition of bicarbonates and, through proper controls, prevent calcium sulphate from coming down.

Freeport has also developed a process which overcomes excessive corrosion. This is done by removing oxygen in a packed tower in which cold sea water flows downward through the packing. In the upper part of the bed the water is contacted with flue gases discharged from the boilers, in the lower part by combustion gases from natural gas burned directly into the tower.

This apparatus serves several purposes: (1) the temperature of the water

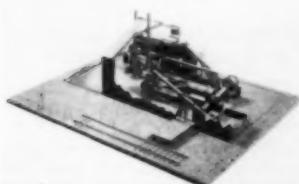
is raised from about 75 to 145 deg. F. and a large amount of heat reclaimed from the boiler flue gases, thereby keeping the overall plant efficiency at 85 to 90 percent; (2) the water is raised to 190 deg. F. by burning fuel in the base of the tower using theoretical combustion air in a pre-mix burner, thus eliminating the heat normally supplied by boiler steam; (3) the water is deoxygenated to less than 0.1 ppm. of dissolved oxygen by contacting the water with the inert flue gases in the base of the tower.

The water is next raised to 325 deg. by means of steam in indirect heat exchangers. Some soft sludge accumulates inside the tubes of the exchangers and causes a loss in the heat transfer rate. This is restored by periodic flushing with steam.

Although the corrosiveness of the water is reduced by deoxygenation, corrosive resistant alloys are needed in the heat exchangers and small pipe fittings. In larger fittings and pipelines, cement-lined steel has been found suitable. In well equipment a protective scale can be deposited by small and controlled injections of chemicals into the water.

Freeport doesn't actually prefer its new plant and process to the conventional Frasch plant where fresh water is available. The initial plant cost of the marsh-type operation is less but its operating costs are expected to be greater.

Yet Freeport knows that the output from its Louisiana marsh operations will alleviate the long-standing sulphur shortage. Bay Ste. Elaine will help the U.S. reach its production goal of 8.4 million tons of Frasch sulphur annually by the end of 1954.



Plan Taconite Pilot Plant

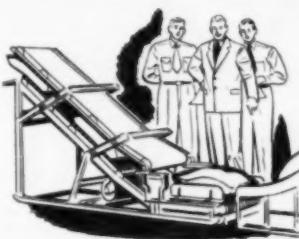
Bulk of U. S. taconite iron ore reserves lies in the Mesabi Range in a solid bed thousands of feet wide, up to 200 ft. thick and 100 mi. or more long. Recently, Allis-Chalmers announced plans for building a \$75,000 pilot plant in Carrollville, Wis., for pelletizing and heat-hardening taconite concentrates brought in by rail from the Mesabi Range.

Pelletizing will be done (note model) in a balling drum, and soft

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3. The guide rails were too far apart so some bags entered the rolls on the diagonal.

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These clinics are informal instruction periods conducted by specially trained Bemis experts for plant personnel who supervise and use bag closing sewing machines. There are demonstrations and discussions on sewing machine operation and maintenance. Motion pictures show efficient installations, the dismantling and reassembling of sewing heads, etc.

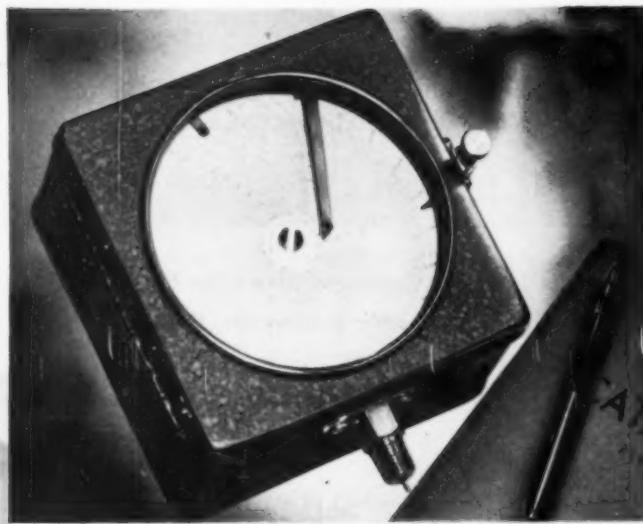
Bemis specialists also assist in planning production line changes . . . and they will recommend new types of equipment, describe latest methods, or help you with special packaging problems.

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Two types available. Type 3 offers several chart ranges, from as low as 0 to 60 psi to as high as 1,500 psi. Type 3-A records very low pressures with chart ranges from 0° to 10° head of water to 0 to 60 psi.



Send for handy catalog-data book

This book describes in detail the many types of Minicorders and lists the wide range of charts available. If you work with indicating or recording instruments this book will be an important addition to your reference library. Please request your free copy on your company letterhead.



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NEWS, cont. . .

pellets pre-dried in a rotating drum prior to being fed to the traveling grate. During travel, the soft pellets will be further dried, then preheated, ignited and burned. Waste heat from the grate is used in the drying and preheating stages.



Soap Builds House

With its 300 ft. glass and stainless steel walls reflecting the heavy structure around it, Lever House stands delicately on its cantilevered base. Last month, Lever Brothers opened their new soap and detergent offices, the latest commercial firm to set up shop on New York's residential Park Ave.

Chemical Industry Could Use Better Quality Sacks

When multiwall paper shipping sacks worked out in shipping fertilizer, the chemical industry started to use them for packing such heavy chemicals as soda ash, sulphur, zinc oxide and alum. By adding to the protective qualities of the present bag, a larger chemical market is possible, according to Materials Handling Manager Dick Lahey of American Cyanamid, who spoke before the Packaging Conference of the American Management Association in Atlantic City last month.

"Specifically, we could use bags having greater resistance to the transmission of water vapor; bags having greater mechanical strength in the form of increased resistance to puncture and even snagging; bags that can

Where industry has the "need" Oronite Chemicals supply the way

WHEN industry needs a chemical which is not available in quantity, Oronite's specialty is finding efficient and economical ways to mass-produce it—meeting the most rigid standards of purity, uniformity and dependability.

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Perhaps our present list of chemicals includes one that will improve your product or process. Possibly we can put a chemical you need in mass production. A letter or telephone call will place our experience and facilities at your service.



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Better grass silage—cheaper

Untreated grass silage is, of course, highly perishable; and though various methods of checking fermentation have been employed, each has had its own drawback—difficulty of application, ineffectiveness, high cost.

Use of liquid sulfur dioxide, begun experimentally in 1940 and established commercially in 1951 by Virginia Smelting Company, has proved a most satisfactory all-round solution to the problem. Under the trade name "Silagas," the company's SO₂ is now in use on hundreds of farms. It has been found to be 30% to 60% lower in cost than any method previously employed—and successful in preserving a high proportion of proteins, organic nutrients and carotene that were lost in earlier ensiling processes.

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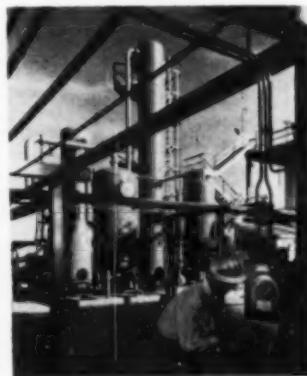
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Chemicals

NEWS, cont. . .

be opened and the product dispensed with no possible contamination from paper, thread or outside; bags with more satisfactory valve closures, and bags with reclosing features.

"We can foresee greater acceptance of these containers if the accuracy of the automatic weighers and packers can be increased.

"The chemical industry has a vital interest in these developments since they represent added markets . . . as well as a possible source of packaging cost economies. We stand ready to assume our share of the practical research and field work. . ."



Ship Channel Plant . . .

. . . completed last month by Ethyl Corp. will boost the company's tetraethyl lead capacity by 50 percent. Present facilities, covering 80 acres, overlook the south bank of the Houston Ship Channel about 17 mi. from downtown Houston. This unit dries hydrogen chloride gas, which subsequently is reacted with ethylene to make ethyl chloride for the tetraethyl lead reaction.

Process Reduces pH Of Irrigation Water

Alkali in irrigation water combines with harmful alkalis in the soil, and clog up the surface. A novel process, now under field tests in California's San Joaquin Valley, makes carbon dioxide, mixes it with irrigation water, neutralizes the alkali and permits water penetration up to 50 percent.

Within 26 to 36 hr. after initial use, tests show greatly improved penetration. One grower reports cotton yield up $\frac{1}{2}$ to $\frac{1}{2}$ bale per acre.

Use of the process, however, does not eliminate the need for additional fertilizer or mineral supplements in deficient soil. The process loosens

the soil and allows foods and minerals to get about.

A pH reducer—the basis of the process—called the Ron-Mar, manufactured and distributed by Soil & Water Correction Co., Pomona, Calif., can be adapted to any irrigation well. In its combustion chamber, which is 1 ft. in diameter and 39 in. long, diesel fuel oil is burned to make the carbon dioxide. The chamber is fired to about 2,200 deg. F. by a standard oil burning unit.

Irrigation water is pumped through the reducer's mixing chamber, an air-tight sheet metal box 18×18×20 in. The flow of water enters the box at the side near the bottom. Inside the box the water rises to about 10 in. to escape through a 4-in. pipe that projects through the bottom of the mixing chamber and leads to the standing pipe or reservoir.

Escaping water creates a vacuum that sucks the carbon dioxide from the combustion chamber through a 6-in. metal tube. The standard size pH reducer handles 1,500 gpm. flow, lists for \$535 fob, Pomona. A \$25 charge is made for installation, but the farmer can install it himself if he has a welding machine.

The manufacturer is working on an adaptation of the unit for use by industry.

First Modern Refinery In Brazil Expanding

Brazil's first modern refinery was completed at Mataripe in the State of Bahia in 1950. Last month, M. W. Kellogg Co. announced construction has started on the expansion of the Bahia plant. The expansion will double the capacity of the present 2,500 bpd. combination thermal refinery.

New facilities will include catalytic polymerization units that will raise the over-all octane rating of finished gasoline, and units for the production of LPG. The original plant will be modified to process the lighter crudes now available from local fields.

Complain Congress Votes Too Little for Research

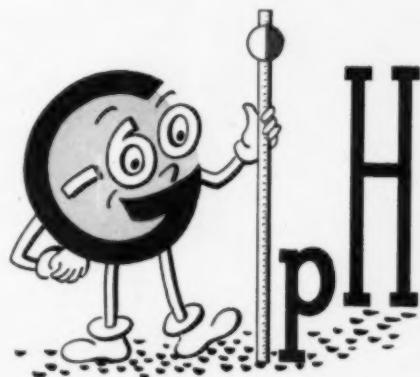
"Please do not misunderstand me. I think the Federal Budget is plenty big enough. I do not wish to see it expand any more. But I think that where science is concerned, it is completely out of balance."

Speaking at the recent national meeting of the American Chemical Society in Buffalo, Research Director E. U. Condon of Corning Glass Works and former head of the Bureau of Standards went on to say,

"Included in the budget for the

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**is equally effective
over the entire pH range!**



You can make the most of the outstanding advantages of this activated carbon of premium purity regardless of the pH of your solutions. Darco G-60 often makes possible the simplification of processes with substantial savings in time and costs.

Darco G-60 gives you the ideal combination of maximum filterability, high adsorptive capacity, and low retention loss—plus freedom from extractable contaminants.

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IMAGINITY AT WORK

In decolorization of materials sensitive to oxidation, activated carbon may introduce enough air in its pore structure to cause trouble. Solution: boil the carbon vigorously with water (or other suitable solvent) for twenty minutes to expel air; decant or filter; and use.

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Highest purity... by the gram or carload



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Snap-on Tools
cut "Down-Time", too

You'll often save enough in labor-time alone, to pay for the right Snap-on Tool to reach hard-to-get-at spots such as these generator coupling flange nuts. The more important savings in "down-time" are so much "velvet."

On this job, as you can see, there's no room for the head of a ratchet wrench, nor is there



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News, cont. . .

current year is some \$1,500 million for scientific research and development on military matters. Thanks to the wisdom of a good many military leaders, quite a bit of this will go to fundamental research, but this is done without the explicit knowledge and sympathetic consent of Congress.

"Scientists have been telling our political leaders for many years that we need more support for basic science in our country. Finally, Congress acted and established the National Science Foundation as a means of giving assistance to projects in our universities in support of fundamental research.

"Having done this, they then appropriated \$300,000 for it to get started, an amount which was upped to \$3 million as a result of a great deal of lobbying. An effort is being made to devote \$15 million to the purpose next year, but the House Appropriations Committee has already acted to cut this back to \$3 million.

"We can and do spend \$1,500 million for applied military research and we will have a budget in excess of \$75 billion altogether and all this goes to operate a society whose entire wealth and productivity are based on scientific progress. But Congress thinks we can only afford \$3 million for fundamental research. This year, ten times that is being spent at the National Bureau of Standards on one military-electronics device alone."

Chemical Facts Backing Theory on Solar System

In broad outline, the theory of the origin of the solar system by condensation and accretion fits the facts reasonably well, according to Harrison Brown, who spoke at the recent national meeting of the American Chemical Society in Buffalo.

Cosmically, there is about four times as much neon as silicon, but on the earth there is ten billion times as much silicon. This indicates that during the earth's formation tremendous quantities of neon were distilled off. From calculations of the amounts of different elements that were thus lost, and the temperature and pressures at which these materials can be distilled, it is possible to reconstruct conditions which prevailed at that time.

The chemical evolution of small earth-like planets appears to have depended in large measure upon the ability of the planets to retain water during the planet formation process and, equally important, to retain water subsequently in their history. . .

The chemist, the geologist, the astronomer, and the physicist, working

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This tough, durable asbestos-cement pipe successfully resists many of the corrosive fumes, vapors, and gases encountered in a wide variety of industrial operations... helps avoid frequent replacements that waste both time and money.

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ducts, vents or stacks in either indoor or outdoor service.

Plant men appreciate its light weight, plus the fact that it can be cut and drilled with ordinary tools. And it comes in a complete range of sizes up to 36" in diameter... with a complete line of rustproof, corrosion-resistant fittings that adapt it to practically any job requirement.

You will find further details on Transite Industrial Vent Pipe in Data Sheet Series DS-336. For your copy write Johns-Manville, Box 290, New York 16, N. Y. In Canada, 199 Bay Street, Toronto, Ontario.



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Johns-Manville
TRANSITE Industrial Vent **PIPE**

News, cont. . .

closely together, can reconstruct successfully the process by which our solar system was formed."



Prodding for Sulphur

This \$225,000 floating drill rig of Freeport Sulphur Co. hovers above the large new brimstone deposits at Garden Island Bay, La. Here, Freeport will build a \$10-15 million mining plant, the largest single sulphur development in the world in the past 20 years.

New Cotton-Rayon Blends Make Superior Fabrics

Already running to capacity in a current slack textile market, chemically modified cotton fabrics may find even heavier service in the near future. Dan River Mills, Inc., has developed a new process, called X-2, its lab designation, that makes possible for the first time really practical blends of cotton with rayon.

By altering the molecular structure of the cellulosic fibers through chemical treatment, the X-2 process turns out fabrics with improved and lasting properties, according to L. K. Fitzgerald, director of research and development for Dan River.

Fabrics so treated have complete washability, very low initial shrinkage and virtually no progressive shrinkage from subsequent washings; increased wear-life, no chlorine retention, resistance to wrinkling, resistance to mildew, no development of resin odors and resistance to perspiration odors.

These blends yield remarkable new cloths that possess the desirable characteristics of both fibers.

"They combine the rich appearance

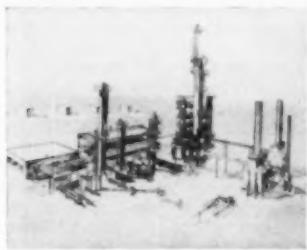
and luster and draping qualities of Rayon, with the wet strength and wear life of cotton. . . The dyeing properties are excellent and give an almost limitless range of fast colors for fashion needs.

"They may be made in light construction suitable for dress goods or shirtings, or in suiting fabrics, or in constructions for sports and work clothes. Made of the two lower priced textile fibers, these fabrics approach very closely to the manufacturer's conception of an ideal fabric."

How Do You Choose a Chemical Plant Site?

Speaking before the recent national meeting of the American Chemical Society in Buffalo, Director of Engineering Carl Hoyer of Chemstrand told fellow members how to select a plant site.

"First, it is important to define accurately the functions of the plant. Then, to have a good idea of the items comprising capital costs. And finally to make a detailed study and a summary analysis of the region and the community. Other than these basic factors, there is no fixed formula that will suggest a scientific approach to the problem of plant site location."



First Fluid Hydroformer

Fluid hydroforming applies the fluid catalyst principle to the reforming of naphthas. Last month, M. W. Kellogg announced that construction began on the world's first fluid hydroformer. Located at Destrehan, La., on the refinery of Pan-Am Southern Corp., the plant will turn out 2,000 bpd. It is scheduled for completion in August.

Principal use of fluid hydroforming: upgrading low-octane naphthas to high-octane motor gasoline. Operated under severe conditions, the process can produce avgas base stocks with aviation ratings of 98 (F-3) and over 175 (F-4) with the addition of 4.6 cc. of tetraethyl lead per gallon. It can also make benzene, toluene and xylene.

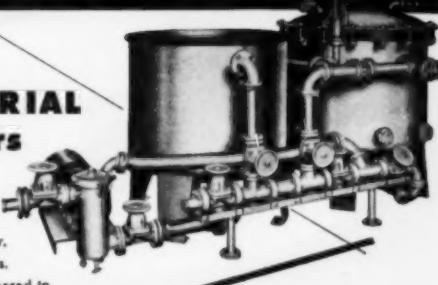
Advantages over fixed bed hydroforming: In the earlier hydroformers,

Bonus Performance IN SOLUTION CLARIFICATION

Any Solution—Any Quantity

INDUSTRIAL Filters

100 to 15,000 gallons per hour.
Portable and stationary models.
Special filtering systems engineered to
meet unusual requirements.

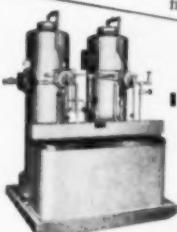


and it's performance that counts . . .

The engineering, design, and construction of INDUSTRIAL filters have proved out in long service. With the outlet near the top of the chamber a uniform precoat is deposited on the filter leaves as the solution fills the chamber. The outside lockup simplifies the lockup of the leaf and bag assemblies. INDUSTRIAL exclusive air-wash cleaning method practically eliminates the usual labor, downtime, and the inconveniences of dismantling the filter after each cycle. INDUSTRIAL filters are often in operation for months without removing the cover. All these features add up to bonus performance—clear filtrate at low over-all cost per gallon.

Ask for Bulletin 100-CPI

This bulletin gives complete information on INDUSTRIAL features, the sizes and capacities of the standard models, and details on the uses of INDUSTRIAL filters for solution clarification.



INDUSTRIAL Ion-Exchange Demineralizers For Low-Cost Chemically Pure Water

Standard INDUSTRIAL demineralizer units are available with capacities of 200 to 1000 gph. Special units of any capacity are engineered to requirements.

Write for Full Information and Recommendations

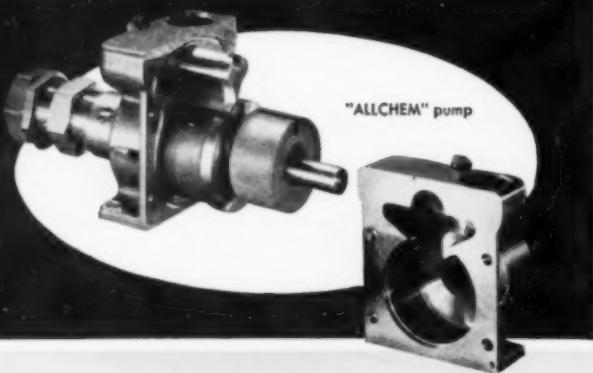
FILTERS PUMPS CORROSION TESTING APPARATUS
Pressure Type Centrifugal Salt Fog • Humidity

INDUSTRIAL FILTER & PUMP MFG. CO.

5918 Ogden Avenue
Chicago 50, Illinois



"Engineered Fluorocarbons" MADE THIS CHEMICAL PUMP POSSIBLE



Impellers, bearings, packing of Chemelac Mixtures (TEFLON®-PLUS) are impervious to chemicals and are non-contaminating, minimize friction, maintain high efficiency.

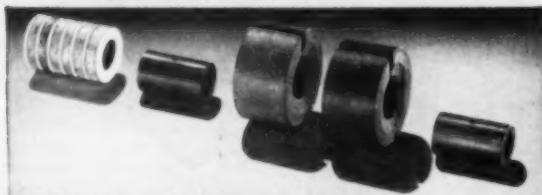
Eco Engineering Company of Newark, New Jersey, makes this "ALLCHEM" pump, suitable for pressures up to 70 lbs., at 3400 R.P.M., for pumping anything that glass can handle—acids, alkalis, solvents, oils, pharmaceuticals, biologicals—with-out chemical attack or contamination.

Chemelac Mixtures are duPont Teflon to which another material has been added in its fabrication to impart some characteristics which the pure fluorocarbon does not possess.

These Teflon "alloys" offer quite

most limitless series of new materials for the designing engineer. Bring us your problem and we will work with you to determine the Chemelac Mixture best suited to your requirements of hardness, wear resistance, dimensional stability, chemical resistance, anti-friction qualities, dielectric or conduction qualities, permanent magnetism, resistance to neutron bombardment, etc.

Also, there are metal surfaced materials which may be soldered to, and materials which are cementable.



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AND OTHER FLUOROCARBON PLASTICS
CAMDEN 1, NEW JERSEY



*duPont's trademark for its tetrafluoroethylene resin

News, cont. . .

reaction beds had to be alternately taken out of production while the catalyst was regenerated. The new fluid system continuously withdraws catalyst from the reaction zone and regenerates it simply and cheaply. Daily operating costs are 30 percent lower; and the new unit costs a third less to build for equivalent capacities.

Tallest vessel is the reactor (see cut). On top of it is the spent catalyst stripper. To the left of the reactor is the regenerator; behind it, the catalyst storage drum. From left to right, the unit's other principal components: control house; compressor house; three recovery towers comprising main fractionator, absorber and stabilizer; the reaction-regeneration section; naphtha furnace; recycle gas furnace; and the blowback air heater.

High-Vacuum Metal Coating Claimed Better Process

In the high-vacuum metallization process, the base plastic or metal is coated with lacquer, then baked. A thin film of evaporated metal is applied under vacuum. Lastly, a lacquer coat is applied, and baking follows to protect the thin metal film.

High-vacuum metallization may eventually replace other processes used for applying a metal finish, according to A. H. Hartman, sales manager of Distillation Products Industries.

Here is why: (1) in most instances . . . lower per unit processing costs; (2) special surface finishes, such as metallic colors and a brushed, hammered, or wrinkled effect can be produced without additional expensive operations; (3) current government restrictions on the use of metals have little effect on the process because it uses only minimal amounts of metal; (4) relatively simple variations of well-known handling techniques can be used; (5) the process is clean and eliminates the handling of dangerous or expensive liquid chemicals; (6) cheaper base materials, such as re-grinds, can be used without interfering with the quality of the final products.

News Briefs

Antibiotics: About one-half of all prescriptions written by physicians today are for antibiotic drugs, according to Henry Welch, director of the Division of Antibiotics in the Federal Food & Drug Administration.

Plutonium: More toxic than radium, plutonium poisons by concentrating in a narrow layer on the bone



**"BUILT-IN"
FIRE-FIGHTING POWER
*that lasts***

In the home or plant, the cry of "fire" is always frightening, and infinitely more so if the extinguisher fails to work.

Based on several such experiences, and goaded by the conviction that "any fire costs more than a dependable fire extinguisher," founders of The Phister Manufacturing Company of Cincinnati, way back in 1918, decided to design an extinguisher "superior to any on the market" and combining these four *musts*:

- 1 It must maintain constant air pressure—without pumping.
- 2 It must be ready to go into operation instantly . . . even after years of disuse.
- 3 Air pressure and liquid level gages must indicate condition at a glance.
- 4 Most important, dependable, corrosion-resistant metals must be used to eliminate the most common cause of failures.

Since the first Phister Extinguisher was built to these specifications, there has not been a single record of failure by corrosion.

Over the years, The American Brass Company has supplied Phister with Anaconda Copper and Copper Alloys in many commercial forms, filling precise requirements of corrosion resistance, close-tolerance dimensions and low-cost fabricating qualities. Perhaps our Technical Department could work with you in a similar way? Write The American Brass Company, General Offices, Waterbury 20, Connecticut.

Phister Fire Extinguishers, featuring "all copper and brass construction," are made in a variety of portable sizes and are readily rechargeable after use. Copper and copper-alloy components provide high resistance to corrosion. Other Anaconda Alloys are used for valve parts, packing nuts, couplings, bushings, gage guards, hose clips, pump parts, etc.

You can depend on

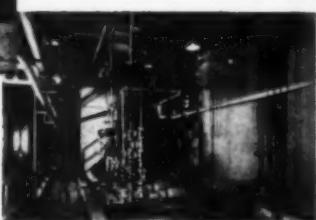
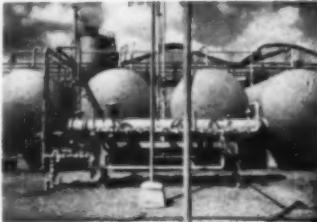
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another

DEL PROTECTED PLANT



DEL PROTECTS AGAINST

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- ALKALIES
- WEATHER
- WATER
- SOLVENTS
- OILS
- ABRASION

Photos by permission
AMERICAN CYANAMID COMPANY

DEL Protective Coatings are designed to do specific jobs in the chemical process industries, on new construction, maintenance and products finishing. The Protective Coating and Plastics industries have made rapid advancements during the past few years. In keeping up with these changes, we have continuously been improving our coatings and developing new ones.

Our engineers and chemists are constantly working to provide coatings to meet the needs of industry. We will be glad to make specific recommendations to assist you with your corrosion problems.

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NEWS, cont. . .

surfaces, close to active cells. It attacks the bone marrow and the cells from which cancer is likely to arise—Argonne National Laboratory.

LITTLE BONER



Impossible!

"It's impossible, I say, to do the trick in less than 19 hours—thermodynamically impossible." The consultant was sure of his ground.

"I don't give a hoot what your theories say, I know it can be done in less than 4 hours." The chief engineer was even more sure of his ground.

This argument came up when a mid-western firm was in the midst of its development work on a new and unorthodox chemical refining process. Success of the whole project hinged on the warming-up period of the engines that were to supply the heat for a critical processing step.

The firm's chief engineer was one of those hard-headed fellows who has picked up his engineering know-how through 45 years of practical experience and shrewd observation. He had never taken an engineering course in his life. Yet he had built up a reputation, in his own field, that was international.

The consultant, too, was known internationally. He was a PhD., author of several engineering and technical books, a consultant to many large chemical firms, active in affairs of the professional societies, professor of chemical engineering at a leading university.

For several months the arguments went on. The consultant gave the problem to his senior class in chemical engineering. Sure enough, the answers came back, "Thermodynamically, it will require a minimum of 19 hours."

But the chief engineer went stubbornly ahead. "I'll bet my experience against your theories," he said.

He did—and won. For when the plant started up, the critical period was only 4 hours, just as he had predicted.

Both men, of course, were right. The consultant's theoretical approach was perfectly sound, but he didn't have all the facts. The chief engineer was lucky that his intuitive approach was also sound. And now that the project has turned out to be a success, it's all a big joke and everybody's happy. If you have a true "little boner," send it to the Editor, *Chemical Engineering*, 230 West 42nd St., New York 36, N. Y.

PORTER

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Steel
Stainless

You'll get positive control and longer life from Porter Lubricated Plug valves . . .
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Illustrated Catalog, showing dimensions, list prices and accessories.
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VALVE DIVISION

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Readers' Views & Comments

To Truman, Too

Sir:

I want to congratulate you on your fine report in the February issue . . . my associates agree with me that it is the best interpretive job on the chemical industry we have seen in a long time.

C. H. SMITH

Consulting Engineers
Chicago, Ill.

► Our editor-in-charge-of-figures hasn't pulled in his chest yet. Within a few days after our February issue came out his figures and estimates began to appear in newspapers, speeches and other publications all over the country.

Results were somewhat amusing. The president of one well-known organization gave a speech, based a good half of it on our report (but no mention of us). A few days later his company sent us a press release which implied maybe we'd be interested in publishing it—with due credit to the speaker, of course!

But our proudest moment came when we saw a copy of Defense Mobilizer Wilson's last report to President Truman. It didn't take us very long to spot some of the figures we'd worked up for our February issue.

In a remote sort of way, then, I guess we could call H.S.T. a reader of Chemical Engineering. But we refuse to claim credit for the course of the nation!—Ed.

Horrors, a Hock Glass!

Sir:

In your November issue (p. 141) you have a picture showing your editor and his guest at Le Cheval Blanc in New York . . . European experts would be shocked to see that they were drinking red wine from a hock glass!

C. J. GOODWIN

Consulting Chemical Engineer
Eastcheap, London
England

► The embarrassment is all Le Cheval Blanc's. Being Irish, the wine tasted just as good to me!—Ed.

Fertilizer Granulation

Sir:

In the February issue of Chemical Engineering, p. 186, Davison Chemical Corp. is listed as adopting a new granulation process for production of mixed fertilizers. The process is described as having been originated by Sturtevant Mill Co.

Although it is true that we are us-

ing a new process, it is one which we ourselves developed, and so far as we know, we are the only manufacturers using it.

W. N. WATMOUGH, JR.

Vice President
Davison Chemical Corp.
Baltimore, Md.

► It is true, as we had pointed out in a previous item, that the new granulation process used by Davison was developed by the company's own engineers. The Sturtevant granulator, on the other hand, has been in use for two or three years and has been adopted by a number of fertilizer plants.—Ed.

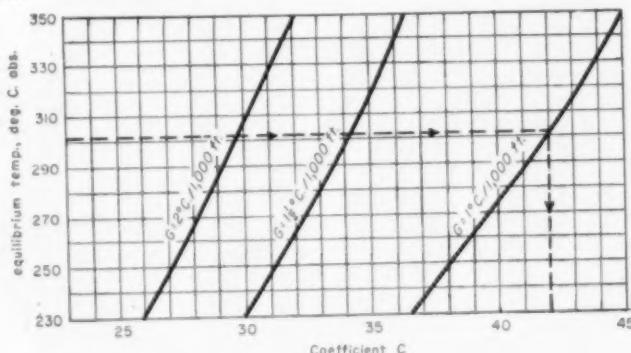
Years Reversed

Sir:

We refer to the article entitled, "Chemical Profits Wilt as Tax Bite Grows," which appeared in the February issue of your magazine. In this article you list nine months' pre-tax net incomes for the years 1950 and 1951 as well as post-tax incomes for the same periods of each year.

Unfortunately, an error was made when the Pfizer earnings were tabulated. Not only was gross income rather than income before provision

(Continued)



Revised data on Stack for Pollution Control

In the second part of the article on "Stacks for Pollution Control," by S. R. Steinbock, appearing on pages 144-47 of our March 1952 issue, a number of corrections have been pointed out by D. H. Barker, Engineering Dept., E. I. du Pont de Nemours & Co., Wilmington, Del. Mr. Steinbock has checked the corrections and provided a new chart to replace Fig. 4a, as well as a number of new calculations.

In the table of nomenclature on page 145 Q should have been defined as the quantity of gas emitted from the stack in cu. ft./sec., expressed at standard conditions of 20 deg. C. and atmospheric pressure. Q_1 should have been defined as the gas quantity Q , also in cu. ft./sec., converted to temperature T_1 . In the problem these quantities were used correctly.

A more serious error occurred in the development of Fig. 4a which is based on the expression $0.43 \sqrt{T_1} Gg$ in Eq. (5). Although the gradient of the potential atmospheric temp. G is often expressed (as in article) in deg.

C./1,000 ft. rise, Bosanquet, Carey and Halton used it as deg. C./ft. rise. This means that, according to the nomenclature of the article the expression for coefficient C in Eq. (5) should be multiplied by $\sqrt{1,000}$. This expression then becomes $13.6 \sqrt{T_1} Gg$. The new Fig. 4a shown here solves this expression.

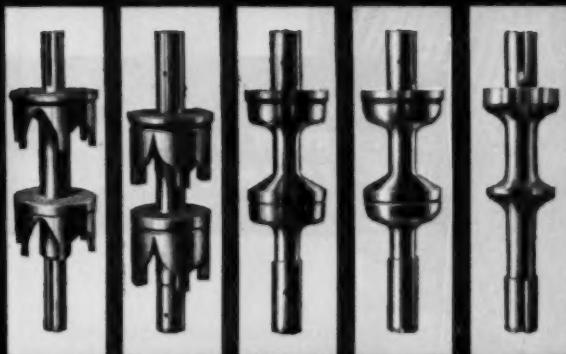
The result of correcting this equation is to change the sample calculation from Step 9 to the end, as shown in the tabulation. It also changes line (9) of the third column on page 146 to read "heights of 103 and 430 ft. at wind" . . .

Revisions for Table on Page 145

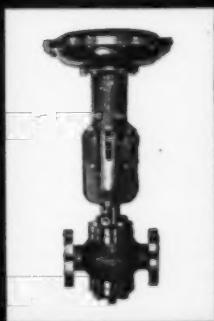
Step	Use Fig. Operation	V = 30	V = 15
9	Find factor J	42	42
10	Find coef. C	0.68	0.68
11	Find coef. E	3.25	0.75
12	Calc factor F	135.5	32.0
13	Find factor P	9.8	6.9
14	Find factor S	7.8	5.9
15	Find net rise	69	350
	Add steps 5&13 102.8	427.5	
	Compare results obtained in steps 7 and 14. Conclude that in this case the effect of the temperature gradient would allow the net rise to reach to the value found in step 14. Since max. height not yet attained at 2,000 ft., use results of step 7.		



WIDE SELECTION . . .



for any valve application

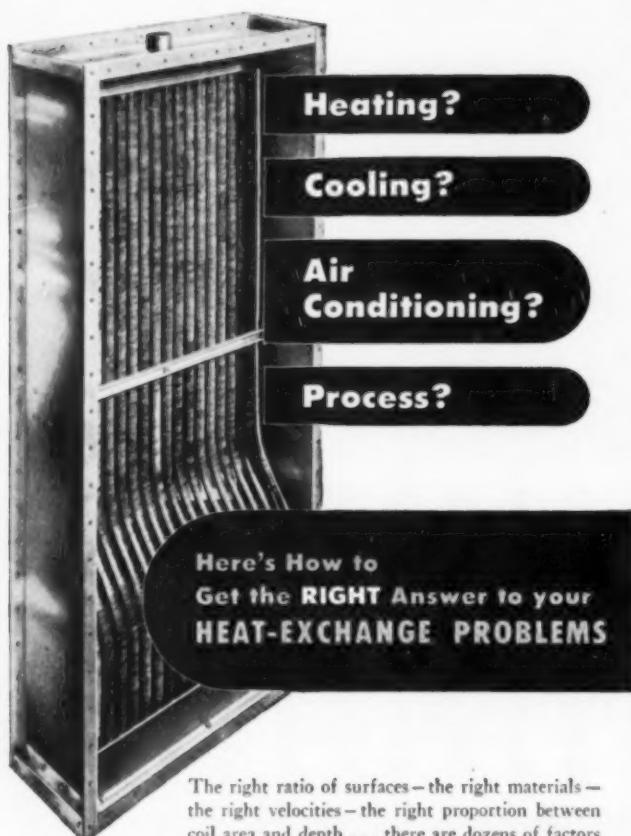


Discs for the Honeywell Series 700 Valve include single and double-seated V-ported and contoured types, each with either linear or equal-percentage characteristics, plus a flat disc for on-off control . . . all ground and polished . . . all designed to retain characteristics under severe service. The Honeywell Series 700 Valve comes in a full range of styles and sizes . . . has all the features you look for in a fine valve. Write today for your copy of Bulletin 700-2. MINNEAPOLIS-HONEYWELL REGULATOR CO., Industrial Division, 1904 Windrim Avenue, Philadelphia 44, Pa.

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The right ratio of surfaces—the right materials—the right velocities—the right proportion between coil area and depth . . . there are dozens of factors that affect the efficiency, maintenance and service life of heat-exchange coils.

For best performance in your own application, the practical approach is to take full advantage of the unequalled engineering, research and design skill—the unequalled manufacturing and testing facilities—which Aerofin offers you.

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READERS' VIEWS, CON't.

for taxes based on income set forth under the columns labeled "Pre-Tax Net Incomes," but the years were reversed in both tabulations. In other words, 1951 earnings were shown in the 1950 columns and vice versa.

G. A. SPECHT

Controller
Chas. Pfizer & Co., Inc.
Brooklyn, N. Y.

► To set the figures straight: post-tax income for the first nine months of 1950 was \$6,777,087 and for the comparable period of 1951 it was \$8,224,172. Pre-tax incomes were \$12,664,417 and \$29,634,972.—Ed.

Pump Mix-Up

Sir:

In your report on pumps (March, p. 161) Mr. Dolman says that if the speed is constant the capacity varies directly as the diameter, the head as the square, the power as the cube.

This seems to me misleading, to say the least. For geometrically similar, or homologous pumps, running at the same speed in revolutions per minute, the diameter exponents are approximately 3, 2 and 5 for capacity head and power respectively. For homologous pumps running at the same peripheral speed the exponents are approximately 2, zero, 2, respectively.

C. HAROLD BERRY

Division of Applied Science
Harvard University
Cambridge, Mass.

Pump Rebuttal

Sir:

Professor Berry has stated the capacity, head and power relationships as functions of impeller diameter for geometrically similar, or homologous pumps.

I was, of course, referring to the same relationships for any given centrifugal pump in which nothing is changed but the outside diameter of the impeller; all other dimensions remaining the same.

Perhaps I should have been more explicit. I dealt with this situation because it is the one which the industrial user is more often concerned with. I believe that my statement is substantially correct, though the relationships are approximate only. They are in common use by pump manufacturers, and are supported by many authorities. (See pp. 89-90 of "Centrifugal and Axial Flow Pumps" by A. J. Stepanoff.)

R. E. DOLMAN

Engineering Department
E. I. du Pont de Nemours & Co.
Wilmington, Del.

Bailey's Thermo

Sir:

I am very much interested in the article by Neil P. Bailey, "New Thermodynamic Concepts Bring Theory and Practice Into Agreement" in the March issue of *Chemical Engineering*. I will certainly want to obtain a copy of the book when it comes out.

I had quite a little trouble in reading the article. I think it is well written but, being schooled in the more classical thermodynamics, I have to shift gears to follow some of the steps.

In particular I had trouble in understanding Eq. (2) on p. 151. I came to the conclusion that this question holds only for adiabatic flow. If I am right, it would be a big help to say in the article that the equation holds for a steadily flowing fluid assuming zero temperature gradient in the fluid.

THEODORE E. BRIDGE
United Engineers & Constructors, Inc.
Philadelphia, Pa.

In the last paragraph on p. 150 the author says "In absence . . . of heat transfer." This is another way—but perhaps a poor one—of saying "adiabatic." He also uses the word "mechanically" to imply zero temperature gradient.—E.D.

Plant Models

Sir:

We are in the process of designing and laying out a small fermentation pilot plant. . . . Can you give us any information as to where we can purchase scale models of tanks, centrifuges, filter presses and other processing equipment or of complete plants?

FRANK BONNER

Design Engineer
Commonwealth Engineering Co.
of Ohio
Dayton, Ohio

We know of two organizations that specialize in chemical plant scale models:

(1) Industrial Models, Arden, Wilmington, Del.

(1) Visual Planning Equipment Co., Oakmont, Pa.

Interest in the use of scale models has surged in recent years, and we get frequent requests similar to that of Reader Bonner's. We believe that many of our readers will be glad to get this additional bit of information.—E.D.

Briquetted Chemicals

Sir:

In looking over your February 1952 issue, I notice on p. 230 the article on briquetting of chemicals. As a matter of interest, we have been bri-



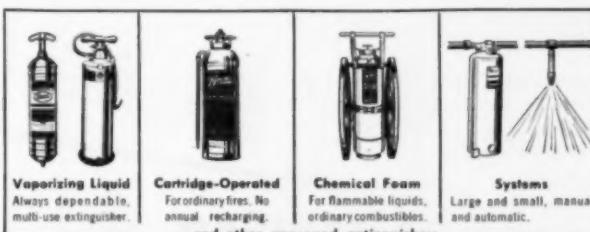
CAREFULNESS ISN'T ENOUGH
YOU NEED PYRENE, TOO!



There's a Pyrene for every fire hazard

The watchword of fire prevention is *Be Careful*. But fire may come—any time. When it does, Pyrene* can make the difference between a harmless scare and a gutted business. Whatever your fire hazard, there's a Pyrene to cope with it—for Pyrene makes everything from hand extinguishers to complete automatic fire-fighting systems.

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Barber Gilsonite is hard, glossy,

brittle, and has an extremely

high melting point. Chemically inert,

Barber Gilsonite may have important values in your processes. We'll be glad

to supply samples and specific data promptly on receipt of your request.



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BARBER GILSONITE SELECTS I
Melting Point Range 270-300° F.

BARBER GILSONITE SELECTS II
Melting Point Range 280-310° F.

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Melting Point Range 325-385° F.

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Melting Point Range 280-310° F.

BARBER STANDARD GILSONITE E
Melting Point Range 335-375° F.

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- BUILDING MATERIALS** • Barber Gilsonite is used as an important ingredient in building materials: floor tiles; building boards and paper; protective coatings and roofing lines.

- MOLDED PRODUCTS** • Barber Gilsonite is a principal component in battery cases and other thermoplastic molded products.

- ELECTRICAL PARTS** • For its high insulating value, Barber Gilsonite has wide application in electrical products and insulating varnishes.

- SPECIAL APPLICATIONS**
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Oakland 1, Calif. Portland 7, Ore. Seattle, Wash. Washington 6, D. C. San Juan 23, P. R.

READERS' VIEWS, cont. . .

quelling chemicals used in water treatment and allied industries for over twenty years, and the company we took over had been briquetting chemicals for ten years prior to that.

Several million pounds are briquetted each month either in ball form or in small pillow-shaped briquettes. This briquetting is especially desirable for irritating or toxic chemicals, such as chlorinated phenol derivatives, because of the elimination of dust.

J. A. HOLMES

Vice President
National Aluminate Corp.
Chicago, Ill.

► We did not intend to imply that briquetting was new to the chemical industry; rather that there is a current strong interest in expanding the application of briquetting to chemicals. Since the appearance of our October report on Agglomeration we have had a number of inquiries from chemical producers wanting to know more about agglomeration operations, mostly briquetting.—Ed.



Roll of Honor Last Call

► Are you one of those old time subscribers waiting for a special invitation? This is it. We want to hear from all readers whose files go back to the days of "Met & Chem" or its several predecessors. Won't you help make the record complete? Write today.—Ed.

Georgia III and IV

Sir:

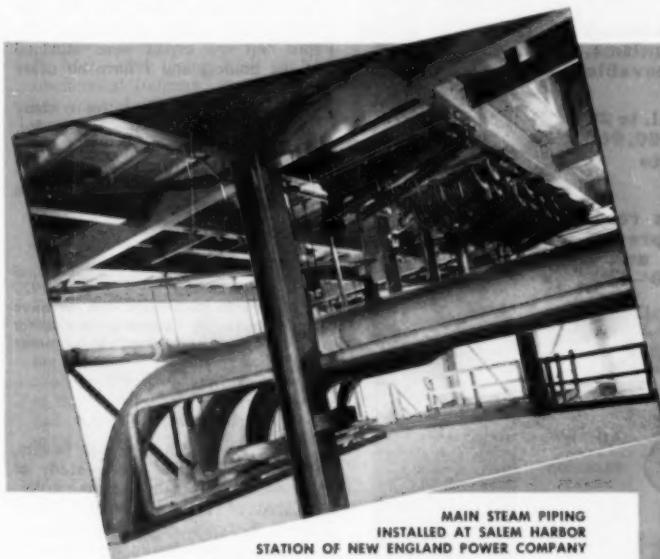
In January you requested old subscribers to tell you when they began taking your magazine. Several years ago I found that the old numbers were becoming a burden to house and dust. Emory University did not have any very old issues, so I gave them mine. They tell me the complete file now starts in January 1916.

J. S. BROGDON

Consulting Chemist
63-17th St., N.E.
Atlanta, Ga.

(Continued)

What it takes to make steam behave at 1450 psi and 1000° F!



MAIN STEAM PIPING
INSTALLED AT SALEM HARBOR
STATION OF NEW ENGLAND POWER COMPANY

Manufacture of this main steam piping began at Pennsylvania Forge Corporation as 20-ton alloy-steel ingots (2½% chrome, 1% moly steel). Four days' forging changed the ingots into solid bars 30 ft. long, with outside diameter of 15½ in. Boring, turning, sizing and finishing followed.

FABRICATION of the main steam line for the Salem Harbor Station of the New England Power Company, vital link in more than 52 miles of piping fabricated by Grinnell, is an example of the many skills required of Grinnell piping specialists. Grinnell chemists, metallurgists, physicists, radiologists and supersonic electronic scientists... all played a part in the bending, welding and testing operations.

The integration of complex, highly technical skills like these into a single organization of trained specialists explains Grinnell's leadership in the field of prefabrication. It explains, too, why your interests are best served when you call upon Grinnell's expert personnel and specialized facilities in the solution of your piping problems.

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Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

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Vessels for continuous reactions can be built for pressures up to 100,000 psi and temperatures up to 2500° F.



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- INSTRUMENTS
- DEAD-WEIGHT GAGES for pressures up to 100,000 psi.

Write for catalogue 406-Q.

Superpressure Division
AMERICAN INSTRUMENT CO.
8010 GEORGIA AVENUE • SILVER SPRING, MARYLAND

READERS' VIEWS, cont. . .

Sir:

Would "Met & Chem" Vol. XVII, July-December 1917, help solve the Georgia problem cited on page 258 of your March issue? That's my first bound volume. My first subscription was taken out the year before, but the copies were damaged at the bindery and I have no other record.

It's interesting to me to see so many "old-timers" from this section, for, as you know, chemical operations were mighty sparse hereabouts before 1919.

J. N. CARUTHERS
439 Woodward Way, N.W.
Atlanta, Ga.

► Our plea for help in arbitrating rival claims between subscribers of June 1920 and May 1921 has brought forth two more entries. Again, the decision is too close for comfort. Further investigations are under way.—Ed.

New York

Sir:

In 1902, at the age of twenty, I became interested in the study of electrochemistry under Dr. Joseph W. Richards of Lehigh University. In the fall of that year he suggested that if I really wanted to be up-to-date in that line I should subscribe to a new journal called *Electrochemical Industry*, which was being edited by his friend, Dr. Roeber.

I am not sure of the exact date of my subscription, but I do know positively that I am missing only two back numbers—September and October 1902—in order to have the complete set from Vol. 1, No. 1. As I did not subscribe until November or December of 1902, I can hardly claim to be a charter subscriber (like Ernest W. LeSueur) but since the fall of 1902 I have been a continuous individual subscriber of *Electrochemical Industry* and all of its successors.

It was my good fortune to number your first editor, Dr. Roeber, among my personal friends. You will find some slight literary contributions under my name in your early volumes. As I had a speaking acquaintance with most of the membership of the American Electrochemical Society in its earliest days, it is just possible that I may have some reliable recollections of fifty years ago that will be helpful to you in your work on the Golden Anniversary Number. You see, I am still a few months short of my "three score years and ten."

COURTLAND F. CARRIER
Chemical Economist and Research Counsel
White Plains, N. J.

► For his amazing memory, boundless energy, and sincere offer of cooperation our thanks to Reader Carrier. We immediately made a date to help the Electrochemical Society celebrate its fiftieth birthday earlier this month in Philadelphia.—Ed.

Virginia

Sir:

I am a long-time reader of Chem. & Met.—even going back to Electrochemical Industry. In fact, I cannot remember the time when your magazine did not come regularly to my desk—at first through my own subscription and of later years through that of my company, Tobacco By-Products & Chemical Co.

The fifty years of effort which you are about to celebrate, and which are coincident with my entire working life, are unique in history. Science and industry have so increased the productive capacity of this country that a man can obtain a vastly better living by working forty hours than he could by working sixty at the turn of the century. Your publication has had a notable part in this development. What of the future?

ROBERT B. ARNOLD

365 Lexington Road
Richmond 26, Va.

► Thanks, Reader Arnold, for turning the tables on us. Our Golden Anniversary Issue, to appear in July, will focus a lot of authoritative attention on what's ahead for the next fifty years!—Ed.

Wisconsin

Sir:

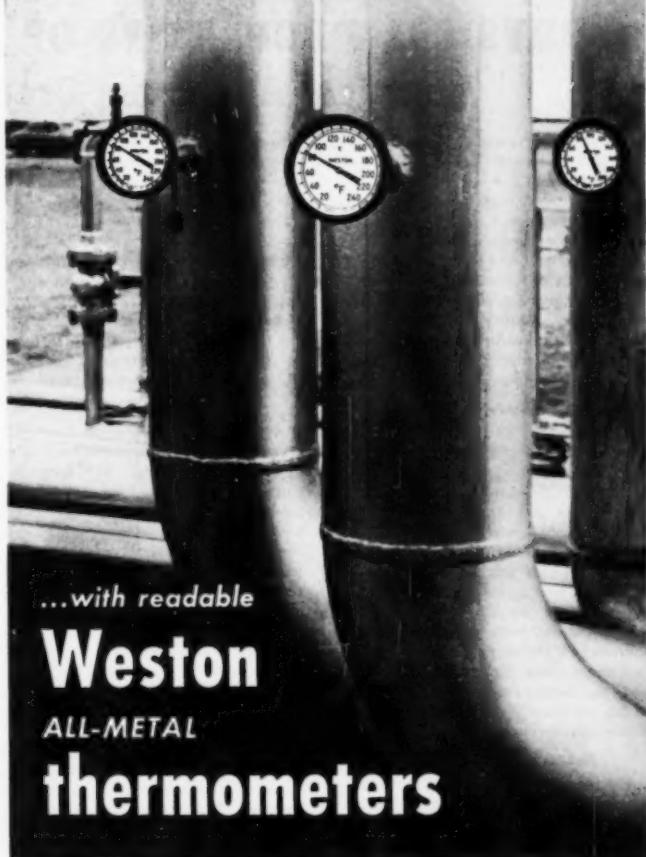
Is it too late for me to apply for admission to your "Roll of Honor?" I began my subscription to Electrochemical and Metallurgical Industry in 1906 with Vol. IV and continued as a subscriber without interruption until my retirement in 1948. Then I had to dispose of my file of bound volumes because in my new quarters there was not room enough for it. In February 1952 I resumed my status as a subscriber, but I did not know about the Honor Roll until I read Oliver W. Storey's fine letter in your March issue.

OTTO L. KOWALKE

Professor-Emeritus of
Chemical Engineering
University of Wisconsin
Madison, Wis.

► O.W.S. was as pleased as we were to hear from his former teacher and colleague, our old-time friend and critic. Storey writes: "When Kowalke was trying to teach us something about chemical engineering during my undergraduate days, he was an ardent booster for your magazine in so far as his students were concerned." We hope to hear more soon about those early days in Madison.—Ed.

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CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN



MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

PHYSICAL PROPERTIES OF DURONZE IV— Arsenical Aluminum Bronze Tubes

Each alloy possesses special physical and chemical properties which makes it ideal for certain conditions. However, since circulating water is subject to continual changes in composition, temperature, velocity, debris, sediment and biofouling, it is difficult to state in advance which alloy will give the maximum service life. Fortunately, considerable data has accumulated with time which gives us a greater insight on the behavior of alloys and their resistance to corrosion.

Fresh Water Conditions

Duronze IV (95% copper, 5% aluminum, and approximately 0.25% arsenic) shows good to excellent resistance to a wide variety of fresh waters. Field tests conducted in Lake Erie showed corrosion rates of a very low order. It is not susceptible to "coppering", a type of attack sometimes encountered in high-zinc brasses where it is known as dezincification. In fresh water polluted with paper mill wastes, Duronze IV showed superior corrosion resistance over the standard copper-base condenser tube alloys. However, in the presence of debris, localized corrosion may occur.

Brine and Sea Water

Duronze IV shows good to excellent corrosion resistance to brines. It is not recommended for use in brines containing a high concentration of sulfides but stands up well when the sulfide content is low.

Duronze IV gives good to excellent performance in sea water depending upon the nature and extent of contamination by industrial refuse and sewage.

Effect of Arsenic

In tests at Kure Beach, North Carolina, conducted in clean, flowing sea water, Duronze IV (arsenical aluminum bronze) proved twice as corrosion-resistant as aluminum bronze without arsenic.

Extensive air-impingement corrosion tests conducted in salt water contaminated by sewage resulted in deep, rapid, localized corrosion pitting in

non-arsenical aluminum bronze. Localized pitting, sometimes called pin-hole attack, is characterized by the formation of narrow pits which rapidly deepen and eventually pierce the tube wall. In contrast with the pits formed by air impingement, the inside surface of these pits is dark and discolored, even scaly. The addition of a small percentage of arsenic to this alloy not only renders it more resistant to air-impingement type of corrosion but improves its resistance to pitting.

Biofouling Retarded

Due to its high corrosion resistance, Duronze IV is susceptible to fouling by marine organisms. The living organisms may obstruct the flow and affect the heat transfer rate. They cause no difficulty as far as corrosion is concerned. However, dead organisms, particularly barnacles, when allowed to remain attached to the surface of the metal, often lead to pitting.

This is explained by the fact that Duronze IV has a low rate of solubility in sea water. It therefore does not introduce to the water film adjacent to its surface enough copper salts to be toxic to marine organisms.

Under conditions where biofouling is severe such as in warm, clean sea water, care should be taken to keep the Duronze IV tubes as clean as possible. The water velocity should be high enough (continuous at 6 feet per second or higher) to prevent marine organisms from attaching themselves to the metal surface. Chlorination should be sufficient to discourage biofouling. Dead marine organisms, particularly barnacles, should be promptly removed by mechanical means.

Paint sprayed on water boxes and tube sheets and inadvertently inside of condenser tubes has led to intense localized pitting. Therefore, paints should be applied cautiously in order to prevent trouble from this source.

Chlorinated Sea Water

Duronze IV is generally more resistant to chlorinated sea water than other copper-base alloys such as Admiralty,

aluminum brass and cupro nickel.

In common with other copper-base alloys, Duronze IV shows excellent corrosion resistance to steam and steam condensate. However, steam condensate contaminated with much ammonia may lead to stress-corrosion cracking. Duronze IV is not recommended for service involving the handling of high concentrations of ammonia. Under such conditions Duplex Tubing with steel to the ammonia side and a copper-base alloy to the water or brine side is very satisfactory.

PHYSICAL AND MECHANICAL PROPERTIES—ALUMINUM BRONZE 53

ANALYSIS

Copper	.94.25
Aluminum	5.5
Arsenic	0.25

MECHANICAL PROPERTIES

Tensile Strength—Soft	50,000
Yield Strength—Soft	20,000
Elongation—Soft	35
Contraction in Area % Soft	70
Rockwell Hardness—Soft	F78
Elastic Limit—Soft	10,000
Modulus of Elasticity in Tension x 10 ⁶	17.5

PHYSICAL CONSTANTS

Density @ 68° F. lb./cu. in.	.295
Specific Gravity	8.16
Melting Pt. °F. Liquids	1945
Solids	1920
Coeficients of Thermal Exp.	
per °F from 68° F to 572° F x 10 ⁻⁶	10.0
per °C from 20° C to 300° C x 10 ⁻⁶	18.0
Thermal Conductivity at	
68° F BTU/sq. ft./hr./°F.	46
Calories/cm. ² /sec./°C	0.19
Thermal Capacity (spec. heat)	
@ 68° F BTU/lb. °F	.99
@ 20° C cal./gm.-°C	.99

THERMAL CONSTANTS

Coeficients of Thermal Exp.	
per °F from 68° F to 572° F x 10 ⁻⁶	10.0
per °C from 20° C to 300° C x 10 ⁻⁶	18.0
Thermal Conductivity at	
68° F BTU/sq. ft./hr./°F.	46
Calories/cm. ² /sec./°C	0.19
Thermal Capacity (spec. heat)	
@ 68° F BTU/lb. °F	.99
@ 20° C cal./gm.-°C	.99
ELECTRICAL CONSTANTS	
Resistivity ohms/mil foot	
@ 68° F (annealed)	.60
Conductivity (IACS)	
@ 68° F (annealed)	17
(annealed) megohm-cm ² @ 20° C	0.099
Resistivity, micro-ohm centimeters	
@ 20° C (annealed)	10
Color	Pink Silver

FABRICATION PROPERTIES

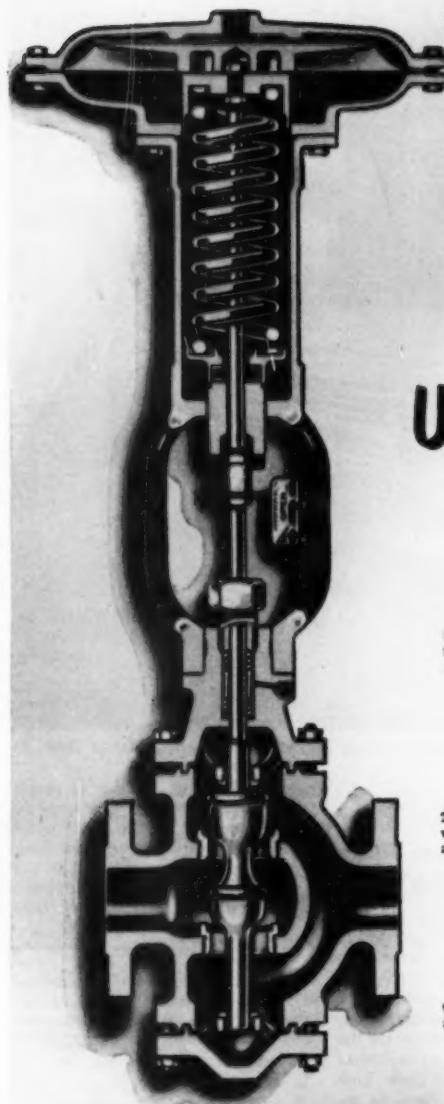
Cold working	Good
Hot working	Good
Hot working Temp. °F	1450-1600
Hot working Temp. °C	800-825
Machinability rating	20
Soft brazing	Good
Silver brazing	Good—special flux
Oxyacetylene welding	Good—coated rods
Carbon arc welding	Good—coated rods
Resistance welding	Fair
Polishing	Good
Annealing Temp. °F	1000-1200

SPECIFICATIONS

A.S.T.M.	B-111-50
A.S.M.E.	SB-111

(8277)

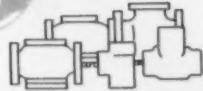
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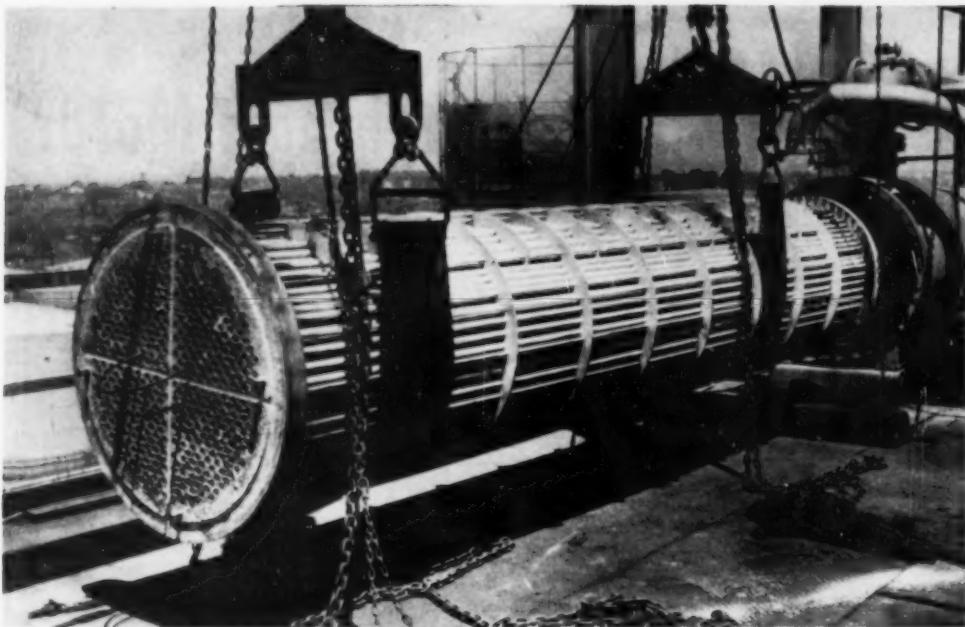
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FOR BETTER PRESSURE CONTROL



Clad 3S aluminum alloy tube bundle from catalytic cracking unit overhead condenser at Sinclair Refining Co., Marcus Hook, Pa.

Aluminum

The corrosion resistance of aluminum and its alloys to over a hundred common corrosives—with data on applications, composition, and mechanical properties.

R. L. HORST

Aluminum Co. of America, New Kensington, Pa.

Properties of aluminum alloys make them useful for many applications in the chemical industries. Their relatively low cost and high resistance to corrosion by various waters, foods, and many chemicals are responsible for their extensive use in chemical process equipment and in the handling and shipment of raw materials and final products. Aluminum salts are colorless, odorless, non-toxic, and insure maintenance of color and quality of products stored in aluminum. For these reasons aluminum alloys are ideal for the shipment of many chemicals by tank car. Too, their light weight enable substantial economies to be realized by their use for shipping drums and tank trucks. The non-

sparking characteristic of aluminum alloys provides enhanced safety for the preparation and handling of explosives or flammable materials. Their high thermal conductivity is used to increase the efficiency of heat transfer equipment such as finned-type exchangers and partially-jacketed kettles. The combination of high resistance to corrosion and electrical conductivity possessed by aluminum alloys has been utilized in electrochemical plants for electrical equipment such as bus bars and other conductors.

Ease of fabrication of aluminum alloys has caused them to be used in a variety of complex equipment. Standard welding techniques can be applied, torch welding being the least expen-

sive. Inert gas arc-welding is usually preferred for chemical equipment because it does not require a flux, which could be corrosive to aluminum if not thoroughly removed. Welding of clad alloys also is commonly done and does not defeat the usefulness of these

Nominal Composition of Aluminum Alloys*

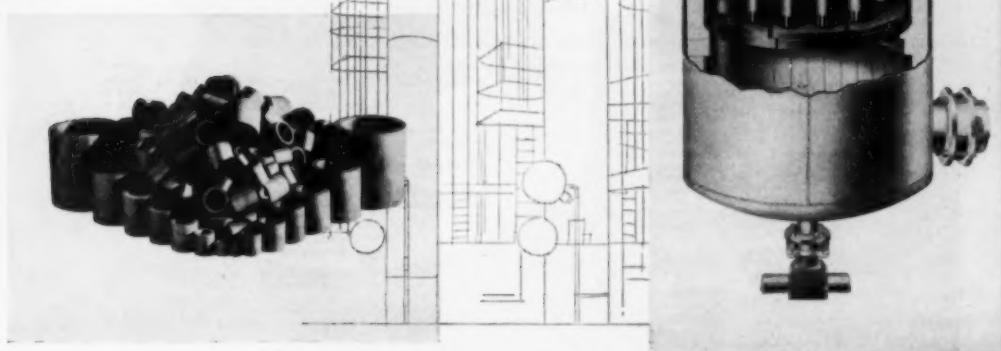
Alloy	Per Cent of Alloying Element, Aluminum and Normal Impurities Constitute Remainder				
	Cu	Si	Mn	Mg	Cr
<i>Wrought</i>					
28 (99% min. Al)
35	1.2	.....	.....
41	1.2	1.0	.....
52S	2.5	0.25	.....
53S	0.7	.....	1.3	0.25
61S	0.25	0.6	.....	1.0	.....
63S	0.4	.....	0.7	.....
<i>Semi-cast</i>					
42	5.0	.....	1.5	.....
214	1.8	.....	3.8	.....
B214	1.8	.....	3.8	.....
220	10.0	.....
355	1.3	5.0	.....	0.5	.....
356	7.0	.....	0.3	.....
<i>Permanent-mold</i>					
43	5.0	.....	0.5	.....
355	1.3	5.0	.....	0.5	.....
356	7.0	.....	0.3	.....

* Heat treatment and temper designating symbols have been omitted since composition does not vary for different heat-treatment practices or tempers.

For low-cost, trouble-free service in ALL types of tower construction

*FIT
THEM...*

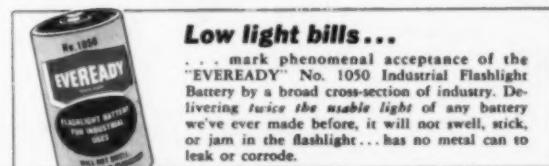
"NATIONAL" Graphite Bubble Caps resist attack by practically all chemicals, INCLUDING ALTERNATING ACIDIC AND ALKALINE CONDITIONS. Of one-piece construction, threaded directly into graphite or "Karbate" impervious Graphite Trays, they are low in cost and function with low pressure drop. Tapered slots provide an effective weir action. Other "National" and "Karbate" tower fittings include distributors and drip-chimneys, support grills, checkerwork and brick and tile shapes of all kinds.



*and
PACK
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"NATIONAL" Carbon Raschig Rings are immune to acid, alkali, and solvent action; have extremely low coefficient of thermal expansion; are light-weight and strongly resistant to chipping and spalling. They have a very attractive overall cost and long service-life. Eight sizes range from $\frac{1}{4}$ " to 3" O.D. Very popular in reaction and scrubbing towers used by the chemical, petroleum and petro-chemical and processing industries.

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CORROSION FORUM, cont. .

alloys since the cladding adjacent to the weld will protect the surface of the weld.

Further adaptability of aluminum alloys for the fabrication of chemical equipment is illustrated by the ease with which they may be brazed. Torch, furnace, and dip brazing all are suitable for joining aluminum. As with welding, the joints must be thoroughly cleaned to remove the flux. In connection with the latter two methods, there are available, in sheet form, duplex or "clad" alloys in which the cladding consists of brazing filler material. The choice of alloy is dependent on the strength and surface required in the finished part. The use of these products is often convenient since it eliminates the necessity of using separate filler material.

Substantial economies can result from the use of intricate shapes produced by the extrusion process. For

example, aluminum alloy tubing can be produced with integral fins, either inside or outside, or on both sides. Complex tubing, composed of two concentric tubes with the inner tube supported and connected to the outer tube by integral fins, also has been extruded.

Another important characteristic of aluminum alloys is that their mechanical properties increase with decreasing temperature. For instance, the tensile strength of aluminum alloy 3S-H14 at -320 deg. F. is about 70 percent greater than at room temperature with no loss in elongation. Several alloys actually show a considerable increase in elongation. These characteristics also apply to welded sections. That aluminum is a particularly suitable metal for many low temperature operations is illustrated by its use as a material of construction in practically all parts of tonnage oxygen plants.

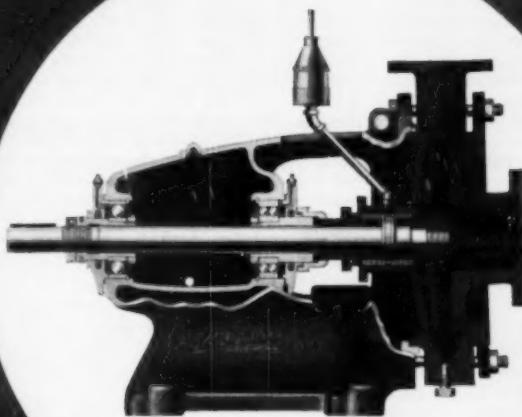
Aluminum alloy seamless pipe is made in iron pipe sizes up to 12 in. Instrument tubing is available in several sizes and lengths up to 1,000 ft. Valves and fittings may be purchased from several suppliers.

Though it is generally good practice to avoid contact between dissimilar metals having widely divergent solution potentials, it may be difficult, in process liquors, to avoid the pickup of heavy-metal salts which may deposit on aluminum equipment and stimulate galvanic corrosion. To combat this type of corrosion, usually characterized by a pitting type of attack, a series of alloys, known as aluminum clad alloys, were developed (Fig. 5). One of these, which is of most immediate interest to the chemical industries, is a clad alloy consisting of a core of alloy 3S (1.2 percent manganese, remainder aluminum) coated on one or more sides with another more anodic alloy,

Aluminum Equipment in the Process Industries—Including Chemicals, Petroleum, Resins, Rubber, and Soap.

Industry	Applications	Alloys Recommended	Industry	Applications	Alloys Recommended
Brewery	Yeast equipment, wort cooler, brew kettle, storage tanks, fermenters, filters, coils, coolers, pasteurizing equipment, beer barrels, carbonating tanks	28, 38, 48, 528, 618, clad 38, clad 48, 43, 214, B214, 356	Edible oils and fats	Deodorizers, condensers, tanks piping	28, 38, 48, 528, 618, clad 38, clad 48, 43, 214, B214, 356
Dairy	Pasteurizers, heat exchangers, milking machines, storage tanks, truck tanks, piping, valves, cheese vats	Same	Glue and edible gelatin	Evaporators, tanks, piping, cookers, drying trays, chutes	Same
Foods	Kettles, conveyors, truck tanks, stock pots, pans, piping, packaging, refrigeration equipment, cookers, storage tanks, drying trays, evaporators, cooling coils, chutes, screens	Same	Aldehydes	Drums, storage tanks, tank cars	Same
Explosives	Ammonium nitrate	Ammonia tanks, evaporators, Name crystallizers, tank cars, piping, drums, storage tanks	Paints, varnishes, naval stores	Stills, condensers, storage tanks, piping, drums, tank cars, kettles, filters, solidification trays, screens, centrifuges, heating coils, heat exchangers, emulsifiers, extractors	28, 38, 48, 528, 618, clad 38, clad 48, 43, 214, B214, 356
	Cellulose acetate	Tanks, acetylator, precipitators, washing equipment, dryers, dephlegmators, stills, condensers, evaporators, piping	Petroleum	Condensers, storage tanks, heat exchangers, instrument tubing, piping, bubble caps, towers, tower sheeting, trays, truck tanks, flame arrestors, paint	Same
	Formaldehyde	Receivers, storage tanks, tank cars, piping	Refrigeration	Compressors, heat exchangers, evaporators, receivers, tubing, name plates, valves, brine tanks, lockers, trays, shelves, grilles, insulation	Same
	Nitroglycerin, gun cotton, dynamite	Hoods, ducts, packaging, filters, storage tanks, wash tanks, extractors	Resins, synthetic	Storage tanks, stills, condensers, receivers, piping, heating coils, weighing tanks, reaction vessels	Same
Inorganic chemicals	Ammonium hydroxide	Condensers, dephlegmators, piping	Rubber	Labor cups, hand carts, storage tanks, acid resistors, regulation vats, bulkier tanks, vulcanization molds, curing equipment, pans, trays	Same
	Hydrogen peroxide	Stills, storage tanks, piping, drums, tank cars, pumps, heat exchangers	Soaps and cosmetics	Condensers, storage tanks, filters, melting tanks, trays, piping	28, 38, 48, 528, 618, clad 38, clad 48, 43, 214, B214, 356
	Nitric acid, fuming	Storage tanks, drums, piping, ducts, hoods	Fatty acids	Essential oils	Same
	Oxygen, tonnage	Heat exchangers, towers, piping	Glycerine	Flasks, containers, drums	Same
	Soda ash	Piping, absorbers, stills, heat exchangers	Textiles	Stills, heat exchangers, receivers, storage tanks, tank cars	Same
	Sulphur	Piping, pumps, tanks, recovery and purification equipment	Rayon	Hoods, ducts, desulphurizing tanks, piping, extractors, pallets, conveyors, precipitators	28, 38, 48, 528, 618, clad 38, clad 48, 43, 214, B214, 356
Microbiological	Fermenting tanks, solution tanks, piping	99.6% aluminum, 28, 38, 528, 618, clad 38, clad 48, 43, 214, B214, 356	Wool, silk	Bleaching equipment, dyeing equipment	Same
Organic chemicals	Lower aliphatic acids	Condensers, receivers, storage tanks, tank cars, piping, oxidizing kettles, crystallizers, filters, melting vessels, pumps	Nylon	Storage tanks, tank cars	Same
	Alcohols	Drums, tanks, piping	Acrylonitrile	Storage tanks, heat exchangers, distillation towers, reactors	Same
		Same	Water, distilled or deionized	Storage tanks, piping, condensers, receivers, valves, fittings, degassifiers	28, 38, 528, 618, 638, 43, 214, B214

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STANDARD
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IN
ALLOYS

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DURICHLOR	DURCO D-10M
DURIMET 20	MONEL METAL
DURCO 18-8-S	INCONEL
DURCO 18-8-S-Mo	NICKEL
CHLORIMET 2	NI-RESIST #2

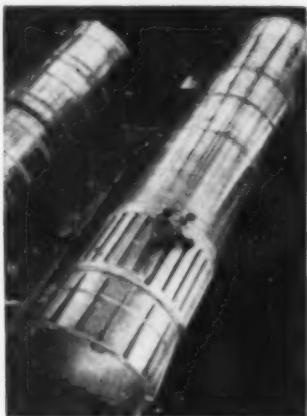
Series R Durcopumps,
designed and built to handle
severe corrosives, are
available in the alloys listed above
as regular production items.
For the details of construction
and performance of industry's
standard acid pumps, write for
free Bulletins P/1 and 100B.



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Welded aluminum alloy storage tanks.



Hydrostatic testing of aluminum tool.



Aluminum prilling tower—Girdler Corp.

Standard Products—Wrought Aluminum Alloys

Alloy	Plate and Sheet	Wire, Rod and Bar	Rolled Shapes	Extruded Shapes	Drawn Tube and Pipe	Rivets	Forgings
Al	*	*	*	*	*
28	*	*	*	*	*
35	*	*	*	*	*
Clad 28	*	*	*	*	*
48	*	*	*	*	*
Clad 48	*	*	*	*	*
528	*	*	*	*	*
538	*	*	*	*	*
618	*	*	*	*	*
638	*	*	*	*	*

72S (1 percent zinc, remainder aluminum). The 72S cladding is metallurgically bonded to the core and nominally comprises 10 percent of the total thickness of the product. Aluminum clad products are very resistant to perforation; a pit reaching the core will not penetrate deeper because of the cathodic protection afforded the core by the cladding. In environments where perforation of non-clad alloys occurs, the use of a clad material will extend the service life of a product or piece of equipment many times. The

clad alloys are extensively used in equipment, such as heat exchangers and condensers, which come in contact with a variety of industrial waters.

By the use of aluminum alloys, not only may substantial economies be realized because of increased service life and reduction in maintenance costs, but in some instances aluminum equipment actually has a lower initial cost. For example, in the smaller sizes of tubular products, aluminum alloys even enjoy an initial price advantage over mild steel tubes.

Typical Mechanical Properties of Aluminum Alloys

Alloy and Temper	Tension			Hardness		Shear		Fatigue	
	Tensile Strength Lb./sq. in.	Yield Strength Lb./sq. in.	Elongation, Percent in 2"	Brinell 500 kg. 10 mm. Ball	Shearing Strength Lb./sq. in.	Endurance Limit Lb./sq. in.			
Wrought Alloys									
99.6-O	10,000	4,000	43	...	19	7,000	3,000		
99.6-H12	12,000	11,000	16	...	23	8,000	4,000		
99.6-H14	14,000	13,000	12	...	26	9,000	5,000		
99.6-H16	16,000	15,000	8	...	30	10,000	6,500		
99.6-H18	19,000	18,000	6	...	35	11,000	6,500		
28-O	13,000	5,000	35	45	23	9,000	5,000		
28-H12	15,500	14,000	12	25	28	10,000	6,000		
28-H14	17,000	15,000	9	30	32	11,000	7,000		
28-H16	20,000	18,000	6	17	38	12,000	8,500		
28-H18	24,000	22,000	5	15	44	13,000	8,500		
38-O	16,000	6,000	30	40	28	11,000	7,000		
38-H12	19,000	17,000	10	20	35	12,000	8,000		
38-H14	21,500	19,000	8	16	40	14,000	9,000		
38-H16	25,000	22,000	5	14	47	15,000	9,500		
38-H18	29,000	26,000	4	10	55	16,000	10,000		
Clad 38	Properties substantially same as for 38								
48-O	26,000	10,000	20	25	45	16,000	14,000		
48-H32	31,000	22,000	10	17	52	17,000	14,500		
48-H34	34,000	27,000	9	12	63	18,000	15,000		
48-H36	37,000	31,000	5	9	70	20,000	15,500		
48-H38	40,000	34,000	5	6	77	21,000	16,000		
Clad 48	Properties substantially same as for 48								
528-O	27,000	12,000	25	30	45	18,000	17,000		
528-H32	34,000	27,000	12	18	63	20,000	17,500		
528-H34	37,000	31,000	10	14	67	21,000	18,000		
528-H36	39,000	34,000	8	10	74	23,000	18,500		
528-H38	41,000	36,000	7	8	85	24,000	19,000		
538-O	16,000	8,000	35	45	26	11,000	8,000		
538-T4	30,000	20,000	21	21	62	18,000	13,000		
538-T5	27,000	21,000	18	20	60	17,000	12,000		
538-T6	37,000	32,000	18	20	80	28,000	13,000		
618-O	18,000	8,000	20	20	30	12,000	9,000		
618-T4	35,000	21,000	20	20	65	24,000	13,500		
618-T6	45,000	40,000	12	17	95	30,000	13,500		
638-T42	22,000	13,000	20	20	42	14,000	9,500		
638-T5	27,000	21,000	18	20	60	17,000	9,500		
638-T6	35,000	31,000	12	14	75	22,000	9,500		
638-T83	38,000	36,000	10	12	82	...	...
638-T831	32,000	29,000	10	12	70	...	...
638-T832	45,000	40,000	10	12	95	...	...
Sand Casting Alloys									
43	19,000	8,000	8.0	40	40	14,000	8,000		
214	25,000	12,000	9.0	50	20,000	13,000			
5214	20,000	13,000	2.0	50	17,000	12,000			
223-T4	46,000	28,000	14.0	75	33,000	8,000			
355-T6	35,000	25,000	3.0	80	28,000	9,000			
356-T6	33,000	24,000	3.5	70	26,000	8,500			
Permanent-Mold Casting Alloys									
43	23,000	9,000	10.0	45	16,000				
355-T6	43,000	27,000	4.0	90	34,000	10,000			
356-T6	40,000	27,000	5.0	90	32,000	13,000			

VINYL COATINGS ENTER NEW ERA

**Revolutionary Prufcoat Primer P-50 Makes it Possible to Apply Vinyl Coatings
by Simple "Prime and Paint" Procedure — Just Like Ordinary Paints**

Here at last is the Big News everyone concerned with maintenance painting has been waiting for . . . the first primer development in the history of protective coatings that takes vinyl base paints out of the "specialty" category. No longer is it necessary to use special application techniques in order to take full advantage of the outstanding chemical resistance provided by vinyl coatings.

NEEDS ONLY ROUTINE SURFACE PREPARATION AND DRIES FAST

Prufcoat Primer P-50 now makes vinyl coatings completely practical for general maintenance painting. Routine wire-brushing to remove flaking rust and other loose corrosion products is normally the only surface preparation necessary. Revolutionary Primer P-50 comes ready-mixed and applies easily by brush or spray. The primed surface air-dries to the touch in minutes, can take final top coat application in a matter of hours.

POSITIVE ADHESION IS ASSURED, UNDERFILM CORROSION CONTROLLED

Prufcoat Primer P-50 bonds securely to either old or new metal, or to previously painted surfaces, and its special nature guarantees firm adhesion of top coats. Vinyl coatings as well as oil

and oleoresinous paints actually weld themselves to a Prufcoat primed surface. In addition, the highly inhibitive properties of amazing Primer P-50 control underfilm corrosion, eliminating all danger of premature failures.

A SINGLE PRIMER FOR EITHER VINYL OR CONVENTIONAL PAINTS

Prufcoat Primer P-50 is truly the ideal primer for all metal surfaces, whether corrosion conditions are such that the heavy duty protection of vinyl top coats is required or whether a conventional paint finish is to be used. Think of the savings in time, trouble and expense this means . . . one easy, sure-fire priming system for all metal surfaces.

Get full information without delay on this important primer development that now makes possible a simple yet positive "Prime and Paint" procedure throughout your plant. You will be truly amazed at what Prufcoat Primer P-50 can mean to you in the terms of easier application, better protection, and lower costs — in the maintenance painting of all structural steel, tanks, pipes, ducts, machinery and equipment. Send for Prufcoat Technical Bulletin No. 015.

Write today!



Grueling Salt Spray Test Proves Prufcoat Performance

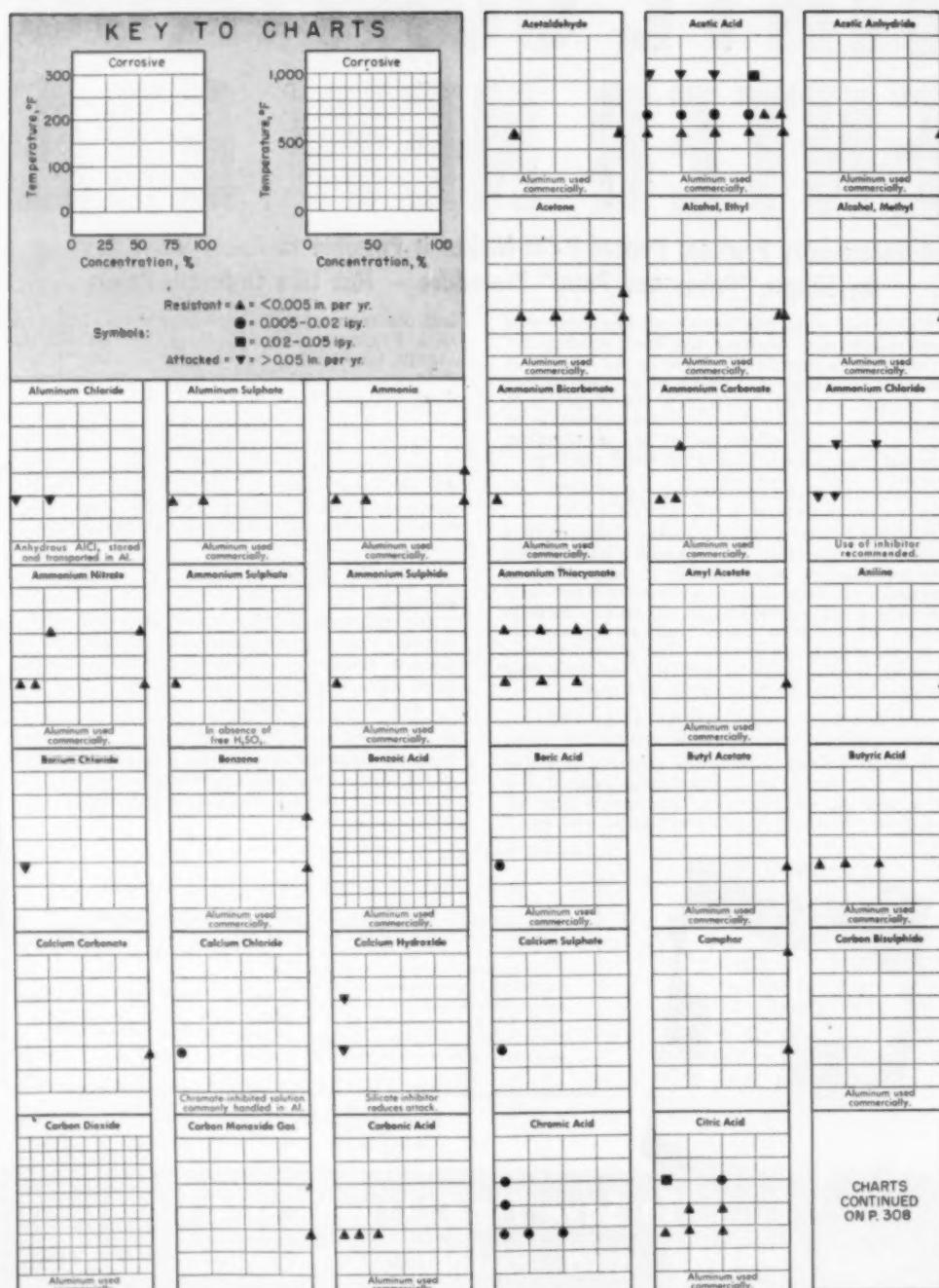
Tough field and laboratory tests in plant after plant report "100% performance" for Prufcoat Primer P-50. For instance, in the laboratory of one of America's leading chemical companies, steel test panels were prepared with one coat of Primer P-50 and one top coat of "A" Series Prufcoat. The painted surfaces were then scored to expose the bare

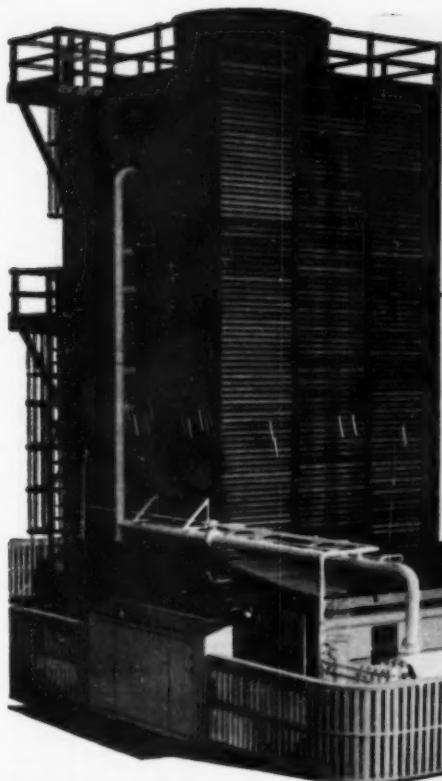
metal and the panels subjected for 672 hours to a 20% salt spray, the acidity of which was adjusted to pH 3. The report states: "Absolutely no failure anywhere on the Prufcoat primed and painted surfaces, and no corrosion creepage under the coatings at the score marks."

PRUFCOAT LABORATORIES, INC.
50 East 42nd Street, New York 17, N. Y.

To Save Time, Trouble and Money...
Just "PRIME and PAINT" with PRUFCOAT

Corrosion Resistance of Aluminum





Fluor Cooling Tower Testing Facilities. This commercial-size installation consists of a pump house, instrument house, 20,000,000 BTU/H boiler, test basin, and a 40' high test tower.

What this means to you...

The motivating power behind Fluor's continuous research and development program is to always provide the most efficient cooling tower available. This fact, combined with Fluor's 30 years of active experience in designing major cooling tower installations for the petroleum, chemical, and power industries, means many things to the man seeking a factual tower recommendation to meet his exact cooling requirements.

A Fluor Cooling Tower recommendation means that all variables are included and compensated for. It means that all component parts, as well as all design theory, have been tested and evaluated under actual operating conditions. And, it means that a Fluor-designed cooling tower will perform at rated heat transfer efficiency under the conditions of installed operation. You can be sure with Fluor!

FLUOR

Designers - Engineers - Constructors - Manufacturers

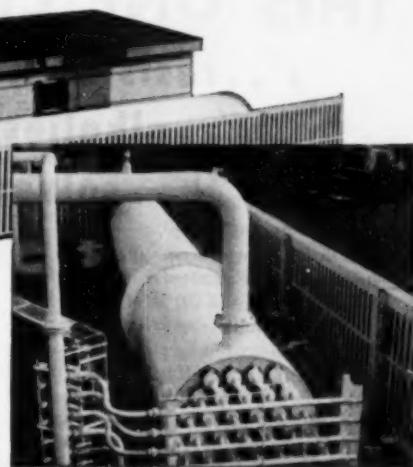
THE FLUOR CORPORATION, LTD., 2500 S. ATLANTIC BLVD., LOS ANGELES 22, CALIF.
New York, Chicago, Pittsburgh, Boston, Tulsa, Houston, San Francisco, Birmingham and Calgary

Represented in the Sterling areas by:
Head Wrightson Processors Ltd., Yeadon House, Baltic Street, London, E.C.1, England

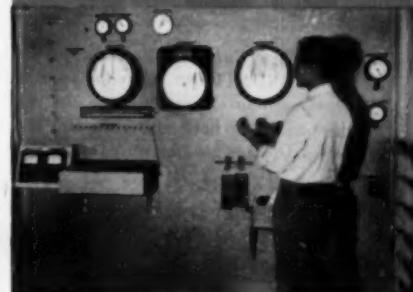
fluor's modern research facilities

test new developments — verify efficiency

At Fluor, the proof of the design is in the testing. Before new Cooling Tower developments are incorporated into standard design, they are subjected to rigorous tests in this modern, commercial-size tower testing laboratory. Here, design and performance efficiency of every new development is determined through complete ranges of actual heat transfer conditions. Realistic rating data is established under conditions paralleling those of plant and process operations.



This specially designed Dutch Marine-Type Boiler provides heating heat output for the test tower. Fired by 37 hydraulically-controlled burners operating on either natural gas or propane, the boiler delivers a maximum heat rate of 30,000,000 BTU/H. Heating is controlled from this single panel. Instrumentation includes measurement and recording of heat loads and water flow rates, air temperatures, hot and cold water temperatures, and static readings and air pressure drop, under a variety of conditions.





THIS ONE CEMENT

- ✓.. resists acids
- ✓.. alkalies
- ✓.. solvents

ALKOR 5E is the nearest approach to a universal corrosion-proof cement. It is the particular combination of resistance characteristics that makes ALKOR 5E of tremendous importance to industry.

It is important for you to know that your acid-proof construction will not be destroyed by alkalies or solvents in any phase of your processing operations. It is also important that you can standardize on this one cement, proven to withstand and protect against such a wide range of corrosives.



ALKOR 5E is a resin cement based on a furfuryl alcohol polymer. In addition to resistance to all non-oxidizing acids, alkalies and solvents; it also resists fats, oils and greases; and may be used for temperatures up to 380° F. ALKOR 5E has no offensive odor; and its low shrinkage assures joints that are level with the brick or tile surface.

NEW Bulletin 5-2... send for your copy today.

RECOMMENDATIONS for your specific requirements may be obtained without obligation from the ATLAS Technical Service. In recommending both materials and constructions for handling corrosives, there is no substitute for 60 years of ATLAS experience.

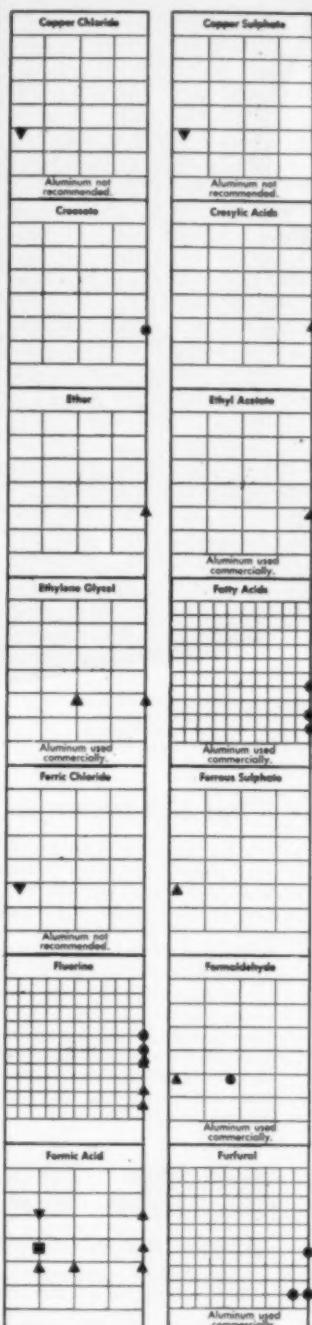
**ATLAS PRODUCTS STAND
...between your process
and corrosion**



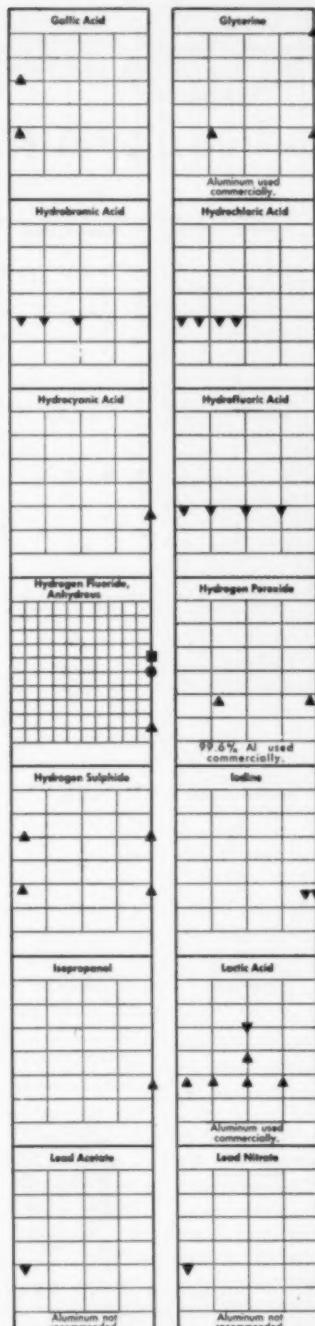
Corrosion-proof: Cements—Coatings—Vessel Linings

CORROSION FORUM, cont. . .

Aluminum (key on p. 306)

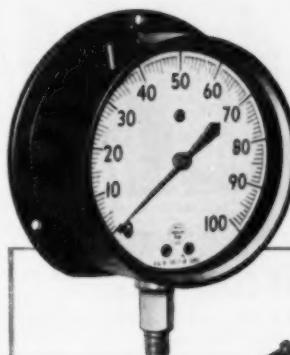


Aluminum (key on p. 306)



HELICOID Chemical Gage

The gage that retains its original accuracy longer, lasts longer, costs less per gage, per year



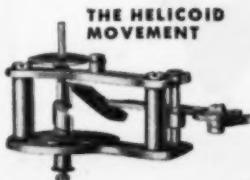
- For chemicals and liquids which would corrode or clog the Bourdon tube. Simple, sturdy construction proved in the field.

Pressures to 3000 p.s.i., vacuum, or compound; temperatures to 400° F. Diaphragm unit may be ordered separately.

FEATURES



- The Helicoid movement is a simple cam and roller arrangement that gives long, trouble-free service. It has no gear teeth to wear out. Helicoid Gages are made in various sizes and shapes, with black, white, or phosphorescent dials. For wall or stem mounting. Helicoid Gages cost less in the long run.



ACCO



Write today
for the Helicoid catalog

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE

927 Connecticut Avenue • Bridgeport 2, Connecticut

HELICOID
Pressure
•
Vacuum
GAGES

(Continued on page 310)

Here's the answer to your acid heating or cooling problem...



HEIL 1277 SHELL AND TUBE EXCHANGER
WITH NOCORDALTM TUBES

LONGER SERVICE LIFE

Nocordal is Practically Inert to Most Strong Acid Solutions.

YOU SAVE TIME AND MONEY

Pre-Engineered Standard Units Available in Field Tested Designs.

LOWER OPERATING COST

Superior Heat Transfer Characteristics Coupled With Efficient Design.

STANDARD DESIGNS AVAILABLE FOR

- Shell and Tube • Immersion Coils
- Electric Units • Jet Agitators

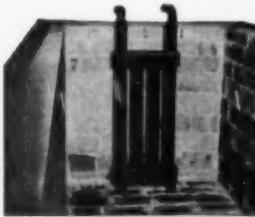
HEIL PROCESS EQUIPMENT CORP. 12901 Elmwood Ave., Cleveland 11, Ohio

Other Heil Products Include: Lined Steel Pipe • Acid Proof Maintenance Materials
• Lined Process Tanks • Lead Fabrication

PUT NOCORDAL*

IMPERVIOUS GRAPHITE HEATING
AND
COOLING UNITS TO WORK FOR YOU

*Trademark



IMMERSION GRID UNIT

Representatives in all
Principal Cities

CORROSION FORUM, cont. . .

Aluminum (key on p. 306)

Lined Oil	Magnesium Chloride
▼	▲
Magnesium Hydroxide	Magnesium Nitrate
▼	▲
Magnesium Sulphate	Malic Acid
▼	▲
Aluminum used commercially.	Methyl Ethyl Ketone
▼	▲
Methyl Chloride	Aluminum used commercially.
▼	▲
Aluminum not recommended.	Naphtha
▼	▲
Monochloroacetic Acid	Aluminum used commercially.
▼	▲
Naphthalene	Aluminum used commercially.
▼	▲
Naphthenic Acids	Aluminum used commercially.
▼	▲
Traces of moisture is effective inhibitor.	Aluminum used commercially.
▼	▲
Nickel Chloride	Nitric Acid
▼	▲
Aluminum not recommended.	Aluminum used commercially.

(Continued on page 312)

U.S.I. SOUND POWERED assures dependable communication

EXPLOSION PROOF

These handsets are approved by Underwriters Laboratories for use in hazardous locations—Class I, Group D.

With weatherproof construction, these sound powered handsets may be used for either permanent or portable communication.

Equipped with press-to-talk switch . . . No batteries, of course.

WRITE FOR CATALOG C-400-B



No.
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UNITED STATES INSTRUMENT CORPORATION
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INDUSTRIAL
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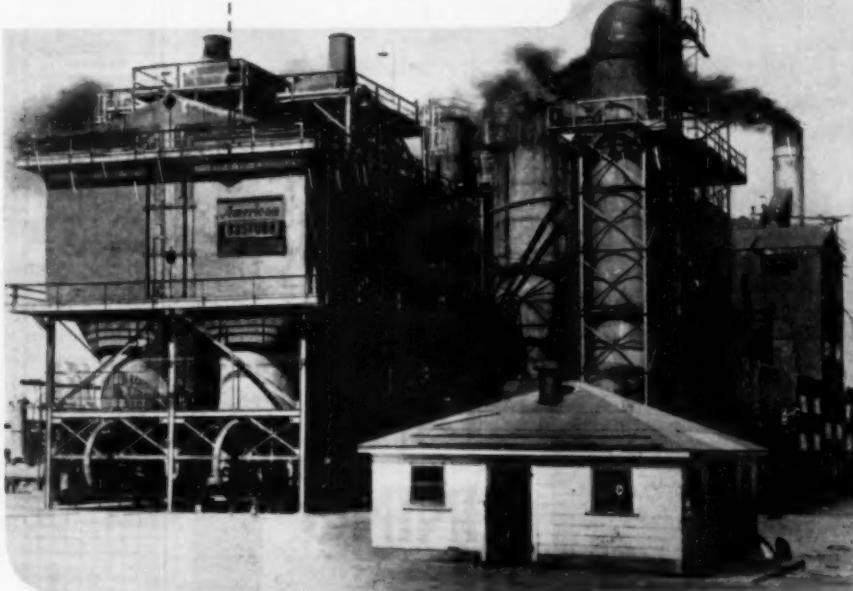
HAND SETS

HEAD SETS

DESK-WALL
SETS

WHAT  **EFFICIENCY MEANS**

IN THE CHEMICAL INDUSTRY



A CLEAN STACK WITH CARBON BLACK

No visible discharge from the two stacks equipped with Dustube Collectors at Cabot Carbon Company! Virtually 100% recovery of extremely fine particle size carbon black is accomplished by the Dustubes filtering the material from 55,000 c.f.m. gas at 275° F. From 10 to 15% of the production of this valuable material had formerly been lost to the atmosphere.

Filtration efficiency like this is typical of the Dustube in the chemical industry because it is the most dependable method of dust removal

that will insure a "clean stack" under a wide variety of operating conditions.

With the new synthetic fabrics, the high efficiency Dustube can now be used under temperature and corrosive conditions in applications heretofore beyond the scope of cloth collection.

For your dust and fume control problems it will pay you to investigate the Dustube—the dust collector that combines simplicity, efficiency and dependability. Write for complete information today.



Catalog 72-B tells why Dustube
is a more efficient method of
dust and fume control. Write
for your copy now.

American
WHEELABRATOR & EQUIPMENT CORP.
347 S. Byrkit St., Mishawaka, Indiana



...is corrosion eating away your profits?



easily installed!
highly resistant to abrasion!

SARAN RUBBER TANK LINING

resists

CORROSION

Saran rubber, developed by The Dow Chemical Company, leads the way to cutting corrosion costs to a minimum. The extremely high degree of chemical and abrasive resistance, found in saran rubber, makes it the outstanding tank lining where the storage and conveyance of grease, solvents, acids or other chemicals is indicated.

Saran rubber can be applied easily and economically by experienced tank

Write to the Distributor:
DEPARTMENT PL. 213

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Charleston, S.C. • Toronto

DEPARTMENT NO. 213

SARAN RUBBER

DOW

CORROSION FORUM, cont. . .

Aluminum (key on p. 306)

Nitroglycerine

Aluminum used commercially.	▲ △ □ ▨ ▨
Nitrous Acid	▲ △ □ ▨ ▨
Oxalic Acid	▲ △ □ ▨ ▨
Phenol	▲ △ □ ▨ ▨
Phthalic Anhydride	▲ △ □ ▨ ▨
Potassium Bromate	▲ △ □ ▨ ▨
Potassium Chlorate	▲ △ □ ▨ ▨
Aluminum used commercially.	▲ △ □ ▨ ▨

Nitroxylic Chloride

Aluminum used commercially.	▼ ▨ ▨
Citric Acid	▼ ▨ ▨
Perchloric Acid	▼ ▨ ▨
Phosphoric Acid	▼ ▨ ▨
Peric Acid	▼ ▨ ▨
Potassium Carbonate	▼ ▨ ▨
Chromic or Chromate acid. Hans inhib. chloro.	▼ ▨ ▨
Potassium Dichromate	▼ ▨ ▨

Aluminum (key on p. 306)

Potassium Ferricyanide	Potassium Ferricyanide
▲	▲
Potassium Hydroxide	Potassium Permanganate
▼▼▼	▲
Aluminum not recommended	Potassium Sulphite
Potassium Nitrate	Pyrogallic Acid
Propionic Acid	Pyrogallic Acid
▼▼ ▾	▲
Aluminum used commercially.	Sodium Acetate
Salicylic Acid	■
Dry	▲
Aluminum used commercially.	Sodium Bisulphite
Sodium Bicarbonate	● ●
Sodium Barite	Sodium Carbonate
▲	▼
Silicate addition inhibitor attack.	

Like the Process Plants they serve

PACIFIC
Precision  *Built*
PUMPS

**are designed and built to operate on
24-hour seven-day-a-week schedule**

✓ **To Engineers responsible
for the purchase of
plant equipment**

Pacific Process Pumps are heavy duty pumps designed to fit your plant—and are fabricated from materials selected for the specific liquid to be pumped.



✓ **To Engineers responsible
for operation and
maintenance of
plant equipment**

Pacific Process Pumps are heavy duty pumps with **EXTRA QUALITIES** built in—qualities of workmanship and materials that prevent painful loss of production and keep maintenance costs down.



✓ **To the Owner
of the plant**

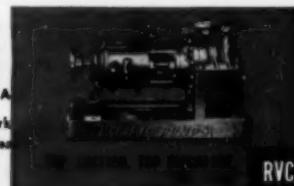
The value of the **EXTRA QUALITIES** built into Pacific Process Pumps is proved by their performance. The following performance record is typical of hundreds of installations: LIQUID PUMPED—hot abrasive slurry; TIME ON STREAM—26,640 hours; AVAILABILITY—100%; PARTS REPLACED AFTER 26,640 HOURS OPERATION—wearing rings and shaft sleeves in each pump, impeller in one pump.

Pacific Pumps inc.

ONE OF THE LEADERS IN INDUSTRY

HUNTINGTON PARK, CALIFORNIA

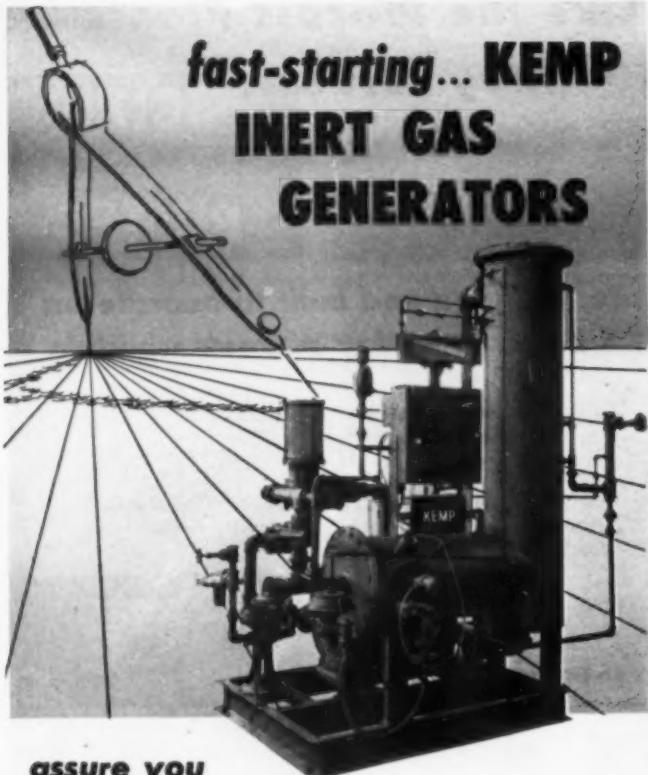
Export Office: Chanin Bldg., 122 E. 42nd St., New York
Offices in All Principal Cities



RVC

(Continued on page 314)

CP-5



**assure you
chemically clean inert
gas at a specific analysis**

PERFORMANCE reports from Kemp users throughout the chemical field show: Kemp Inert Gas Generators produce and maintain a *specific analysis* of chemically clean inert gas regardless of demand. Eliminate the possibility of mixture fluctuations at some critical phase of processing . . . offer the *best selection* of versatile, flexible designs. And in addition, each Kemp Generator is engineered for fast-starting, easy operation so as to save you both time and money spent on the warm-up periods.

You can't go wrong when you specify Kemp.

Set it...forget it!

The Kemp Industrial Carburetor, standard equipment and the very heart of every Kemp installation, assures you complete combustion . . . without tinkering . . . without waste. Uses ordinary gas right from mains. Every Kemp Design includes complete up-to-the-minute fire checks and safety devices. Why not find out how Kemp can help you with your problems, today?

KEMP
OF BALTIMORE

INERT GAS GENERATORS

Write for Bulletin I-10 for technical information
THE C. M. KEMP MFG. CO.
403 E. Oliver Street, Baltimore 2, Md.

INDUSTRIAL • MINING • PETROLEUM • AEROSPACE & PETRO GAS INDUSTRIES
REFINERY SYSTEMS • METAL HEATING UNITS • CHIMNEY EQUIPMENT • FURNACE EQUIPMENT

CORROSION FORUM, cont. . .

Aluminum (key on p. 306)

Sodium Chlorate	Sodium Chloride
●	●
▲	■
Aluminum used commercially.	Aluminum used commercially.
Sodium Cyanide	Sodium Hydrosulfide
▼	▼▼▼
Aluminate or chromate additions inhibit attack.	Aluminum not recommended.
Sodium Nitrate	Sodium Oxalate
▲ ▲	▲
Sodium Sulphate	Stomach Chloride
▲	▼▼
Aluminum not recommended.	Aluminum not recommended.
Stomach Chloride	Steam
▼▼	●●●
Aluminum not recommended.	Aluminum used commercially.
Stomachous Chloride	Succinic Acid
▼▼	●●●
Aluminum not recommended.	Aluminum used commercially.
Succinic Acid	Steam
Traces of moisture is effective inhibitor.	●●●
Aluminum used commercially.	Aluminum used commercially.
Sulphur	Sulphur Containing Oils
●●●	●●●
Aluminum used commercially.	Aluminum used commercially.

(Continued on page 316)

QUAKER *Production-eered** PACKING



CUTS GASKET "BLOWOUTS"
...50 TO 1

QUAKER RUBBER PACKING

GIVES LONG, CONTINUOUS SERVICE . . . FREE FROM HIGH REPLACEMENT COSTS

Plagued by constant gasket "blow out" trouble on a high pressure creosoting cylinder, this Texas processing plant used to take it on the chin. Gaskets were replaced every 3 weeks. While the production curve took a nose dive, replacement costs soared sky high. Then they discovered the answer—tough rubber packing "Production-eered" for the job by QUAKER. Each QUAKER gasket has lasted three years or more—sealing against 200 lbs. pressure at 212° F. Savings: labor plus one QUAKER gasket—as compared to down-time and installation of some 50 previous gaskets.

Just one more example of QUAKER "Production-eering" at work. Let an experienced QUAKER "Production-eer" help you boost production, cut costs with QUAKER "Production-eered" packing, hose, belting and molded rubber products.

***Production-eering**—Every Quaker Industrial Rubber Product is "Production-eered"—engineered to provide maximum life, efficiency and production on each type of installation. Quaker "Production-eers" are ready to recommend the right rubber product for the job. For timely production tips get the new free booklet on "Production-eering for Industry." Write today.



Get This Book →

QUAKER RUBBER CORPORATION
DIVISION OF H. K. PORTER COMPANY, INC.

PHILADELPHIA 24, PA. • BRANCHES IN PRINCIPAL CITIES



IF **FEED CONTROL**

IS YOUR PROBLEM
THEN INVESTIGATE
HARDINGE
ELECTRIC EAR®



To keep your **GRINDING MILLS** (upper right) operating at peak efficiency at all times, Hardinge has developed the "Electric Ear" (center right), a unique feed control that regulates the feed rate by listening to the sound of the rotating load.

The "ELECTRIC EAR" compensates for changes in hardness and size of feed and enables you to produce a more uniform oversize. It increases mill efficiency 8 to 20% * and frees the operator for other duties.

A perfect grinding team is the Hardinge "Electric Ear" controlling the operating rate of the Hardinge **CONSTANT-WEIGHT FEEDER** (lower right) which regulates feeding materials by weight instead of volume.

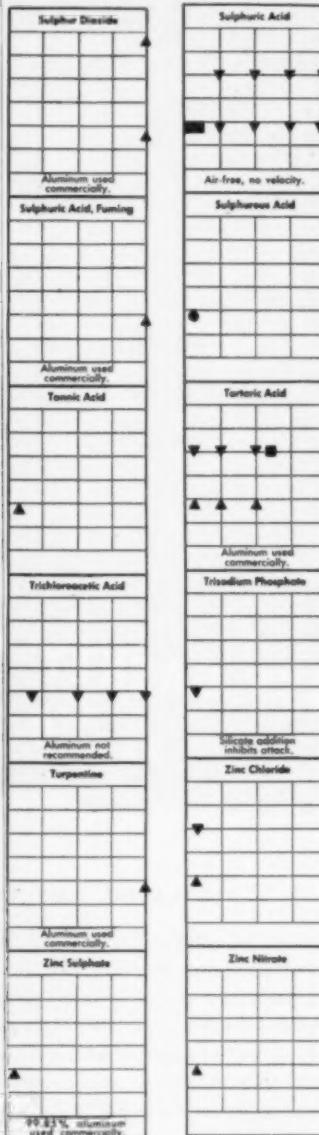
Write for Bulletin 42-18 today.

* These figures are based upon several hundred tested units.



CORROSION FORUM, cont. .

Aluminum (key on p. 306)



Notice . . .

This is the sixth in a series of chart data presentations giving corrosion data for various materials of construction vs. a number of corrosives. Data for the corrosives of particular interest to you will be increased as the coverage grows to include all of the major materials of construction.

Enter—Alloy Steels for 900—1,400 Deg. F. Range

Research at Battelle Memorial Institute, has been concentrated on developing a heat resistant material of lower alloy content that the high nickel alloys frequently used in 900-1,400 deg. F. service. From knowledge of the iron-chromium-nickel alloy system and field experience, casting metallurgists selected an alloy containing 21 percent chromium and 9 percent nickel, designated as the HF type, as the material most likely to provide the combination of strength and corrosion resistance required for "intermediate temperature" (900-1,400 deg. F.) service. Tests to date indicate that this alloy offers a promising solution to the requirements of such service.

Several years ago it was recognized that increased use of industrial processes operating in the 900-1,400 deg. F. range would create a demand for a somewhat lower allowed material than the grades normally employed at higher temperatures. A limited alloy development study was authorized by the Alloy Casting Institute as part of the broad high temperature research program sponsored at Battelle for many years by the national organization of high alloy foundries. But when the post-Korea rearmament program rapidly brought about a shortage in the nickel supply, this added incentive caused the project to be given prime consideration, and intensive work was started in October 1950.

By June 1951 the nickel shortage became so acute that the National Production Authority started a program of "downgrading" alloys. This was formalized for heat resistant materials by order M-80, Schedule C, issued last December. The order places maximum limits on the nickel and nickel-chromium contents permitted for various temperature zones. For certain furnace parts and for oil refinery, synthetic rubber processing, cement mill and power boiler equipment in the intermediate temperature zone, the order limits maximum nickel content to 11 percent. Thus, alloys of the HF composition are the maximum permitted by the order for such uses.

The Battelle research team, under the supervision of J. H. Jackson, is now investigating a series of 14 compositions within the HF alloy specification range, to determine which compositions will offer optimum mechanical properties at elevated temperatures. If the present research on HF alloy continues favorable, then users should be able to substitute this grade in many intermediate temperature applications for materials con-

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Portable R-C Inert Gas Generator used for purging operations and stand-by protection in large gas-producing plant. Capacity 15,000 cfm.



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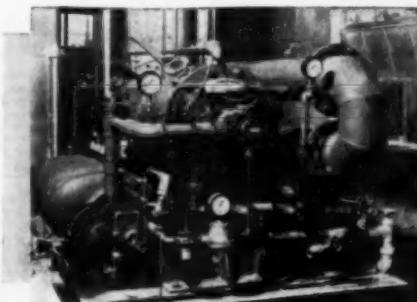
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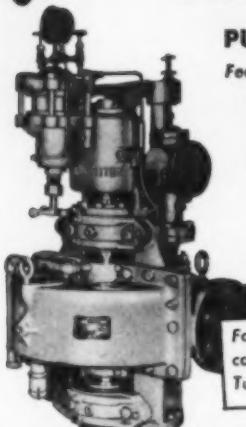
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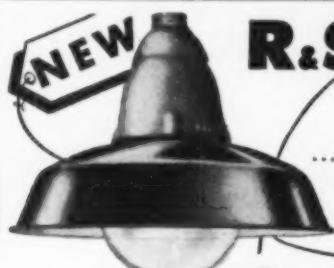
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CORROSION FORUM, cont. . .

taining from 30 to 100 percent more nickel, thereby freeing supplies of this vital element for higher temperature applications, where its use is indispensable.

The HF grade probably would have been investigated for this use a long time ago, except for the mistaken assumption that its properties in the 900-1,400 deg. F. range are markedly inferior to the higher alloy materials now used. This incorrect idea doubtless arose from the fact that the wrought stainless steels containing about 18 percent chromium and 8 percent nickel, have considerably less high temperature strength than the cast alloys of the 25 percent chromium—12 percent nickel and the 35 percent nickel—15 percent chromium types. However, this is not true in cast alloys, since the latitude of compositions possible in cast alloys allows use of chemical ranges unsuited to wrought alloy production. Tests now being made indicate the cast HF materials to have strength properties comparable to higher alloyed cast grades at these intermediate temperatures.

This development is a striking illustration of the fact that the same nominal composition in wrought and cast alloys does not mean that mechanical properties of each material are the same—frequently, they are quite different. This situation points up the necessity for using the ACI alloy designations in ordering castings, rather than the AISI type numbers (302, 304, etc.) which are associated with wrought materials only.

Lead-Clad Copper Branches Out

Lead-clad copper cooling coils used in conjunction with Freon refrigerants, and lead-clad copper electrodes are among the newer developments in the use of this material of construction which are of interest to chemical engineers.

D. T. Armstrong, metallurgist-Grumman Aircraft Engineering Co., and Jack Montgomery, South Shore Refrigeration, recently announced these developments. The work was carried out using Cupralume chemically-bonded lead-clad copper, developed by Knapp Mills, Inc.

Coils of lead-clad copper using direct expansion of Freon lend themselves to severe cooling problems involving sulphuric acid. Lead supplies the corrosion resistance, copper the optimum combination of heat transfer and strength, and Freon (non-corrosive to copper) the cooling over that attainable with water. Such coils



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The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintain 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

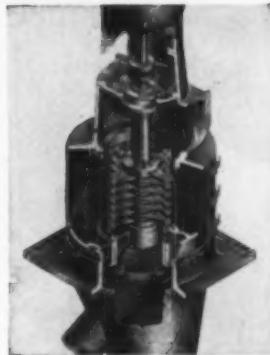
Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

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CORROSION FORUM, cont. . .

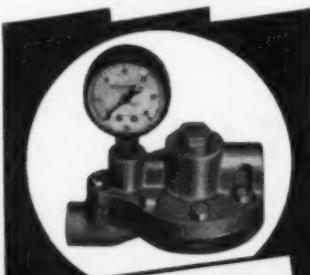
are contributing toward the mass production of anodized aluminum.

Electrodes made of lead-clad copper have the advantage over standard lead electrodes in that lead possesses only 7 percent of the current capacity provided by copper. A variety of improvements in hard chrome plating, in electrochemical processes, and in the function of storage batteries now seem probable.

Progress is being made in the field of copper-clad steel, as well. A new patented method of inseparably bonding the two metals using a vapor flux has been developed by W. L. Ulmer, of the Superior Flux and Manufacturing Co., Cleveland. He claims that the other copper cladding processes yield sheets or plates that are not ordinarily completely bonded, and the sheets made do not usually take deep draws as do sheets made by the new process. Copper-clad steel is used where the strength of steel and the corrosion resistance of copper are desired, as in tubing, tanks, digesters, etc.

The Whitney-Apollo Corporation, Apollo, Pa., are licensees of the new process, and are getting ready to go into production of copper-clad sheet.

—End



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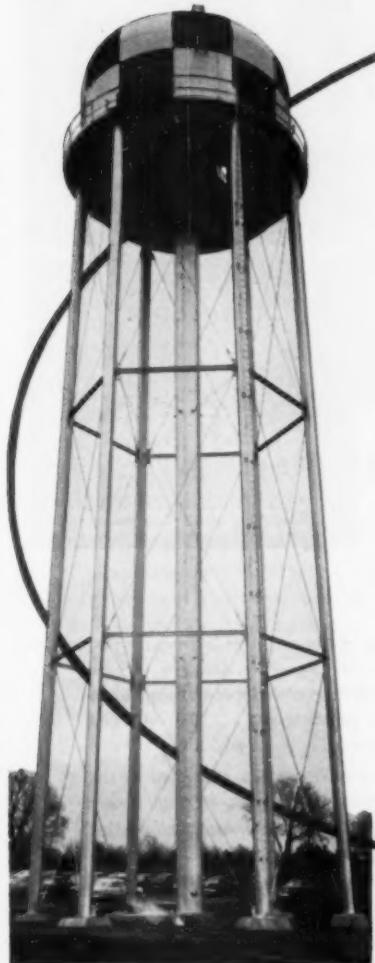
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POSEY IRON

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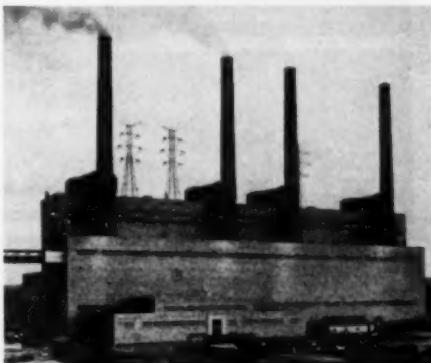


Large industries . . . and small . . . save money by consulting the Posey Iron Works at four critical points in tank fabrication:

1. When type and size of tank are being determined. In its forty-two years of practical experience, the Posey Iron Works has accumulated a thorough "backlog" of helpful information.
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These four Posey Iron stacks measure 23' diameter x 12'6" diameter x 192' 6" high.

POSEY IRON WORKS, INC.

Steel Plate Division

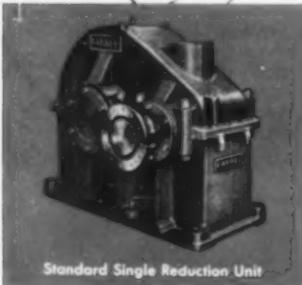
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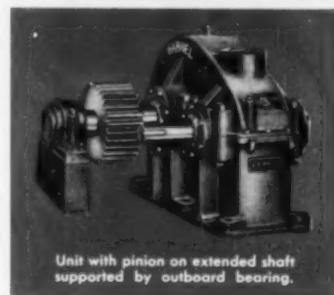
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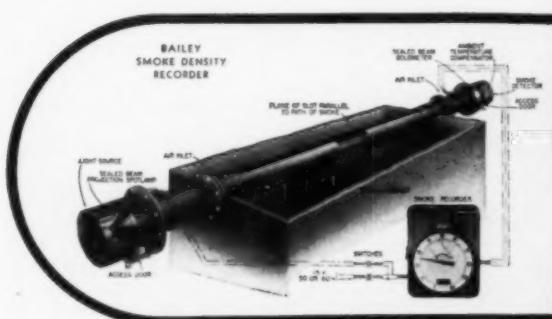
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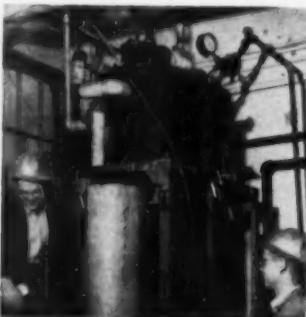
TEMPERATURE • FLOW
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You and Your Job

Edited by Richard V. Reeves



The author suggests quick calculating . . .



Crude setups for fast, definite answers.

Tips for Engineers in Research

To contribute effectively to research you need a bag of engineering tricks, a knack for rapid mental calculations, common sense that gets to the heart of a problem. Developing these may double your efficiency.

C. H. WINTER, JR.

In industrial research, one principle usually overrides all others: get the answer as quickly as safety and the required degree of accuracy permits! Time is the essence of research costs and research results. Many ideas can be evaluated by a single—or maybe a very few—well-chosen critical tests. Many engineering calculations can be approximated by simple rules of thumb. If roughly quantitative tests and approximate answers are acceptable—and they usually are in the early stages of an investigation*—then engineers in research should be just as able to carry out the shortcut methods as they are able to execute detailed calculations and experiments.

The engineer in research who guides himself by these principles will probably find himself doing things which appall his design and construction brethren as crude engineering. This is as it should be. The job is to get the answers quickly, not to impress other segments of the profession. Engineering excellence is a subjective

quality that has no place in the objective business of research.

GET TO THE HEART OF THE PROBLEM

Yet how often does a young engineer spend days enthusiastically exercising his ability to size a heat exchanger neatly or to save Btu's when he should be working to answer the all-important question, will this process work?

The engineer in research should get to the heart of the experiment. He should not hesitate to do things unconventionally if such actions will help to avoid delay.

LEARN RAPID MENTAL CALCULATING

If crude engineering is to be condoned—or even encouraged—to save time, it follows that the engineer in research should develop methods for obtaining approximate answers in a hurry on routine calculations in fluid flow, heat transfer, and the like. If these methods are simple enough for mental arithmetic, the engineer will find that using them will help him

* There are actually two kinds of engineering involved in research: (1) screening of possible products and processes to get approximate, but definitive, answers with the minimum expense in time, money and manpower; (2) careful development of process and engineering data for use by design engineers. The author is speaking about the first type exclusively.

think in quantitative terms. They will help him get the feel of problems. Later, as a supervisor, these methods will help him to check mentally the work of his men and thereby keep up with them. His ability to contribute to group discussions will increase. These tools are self sharpening.

Here are examples of quick calculating methods that require only a little practice to master. A good method, when recognized, should be examined critically and then exercised consciously until it becomes a subconscious thought process. One of the best examples of such a method is the velocity head concept of fluid flow described by C. E. Lapple (*Chem. Eng.*, May 1949, p. 96):

1. 8 ft./sec. of any fluid will develop a velocity head of 1 ft. of that fluid.
2. Velocity head varies as the square of velocity.

3. In turbulent flow, the static head will decrease by one velocity head for every 30 to 40 pipe diameters.

The concept can be roughly extended by assuming a loss of one velocity head for each change of direction or enlargement. On small lines this method will generally suffice to permit quick calculations of minimum standard pipe size.

Another tool is the $1/e$ rule for roughing out a multitude of problems involving logarithmic decrement or decay. This rule is easier to use than to state:

When something is changing at a rate which diminishes in proportion to how much remains unchanged, it will be $1/e$ or 37 percent unchanged at the time it would have been completed had the initial rate been maintained.

Example 1: A 100 CFM positive displacement pump is used to evacuate a 100 cu. ft. tank. What will the pressure be after 1 min?

Ans.: 0.37 atm.

What will the pressure be after 2 min?

Ans.: $0.37 \times 0.37 = 0.137$ atm.

How long will it take to pump down to 10 mm.?

Ans.: After first minute: $760 \times 0.37 = 280$ mm.

After second minute: $280 \times 0.37 = 104$ mm.

After third minute: $104 \times 0.37 = 38$ mm.

After fourth minute: $38 \times 0.37 = 14$ mm. Call it a 4+ min.

This problem may be roughed out

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Amonium-Aqueous	Potassium Hydroxide
Aniline	Pyrogallic Acid
Amyl Acetate	Pickling Acid—complete information required
Benzene	Producer Gas (corrosive)
Benzene Containing Sulfur	Rayon Solutions (except those containing copper salts and oxalic acid)
Bleach	Beeswax
Brines—Acid	Salt Brines
Brines—Neutral	Salty Crude Oils
Brines—Alkaline	Sewage
Calcium Chloride (Acid)	Sludge Acid (Petroleum and Coke By-product)
Calcium Chloride (Alkaline)	Soda Ash
Calcium Hydroxide	Sodium Aluminite
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Coustic Soda—25% 150°F.	Sodium Carbonate
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Coustic Soda—50% 220°F.	Sodium Silicate
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Chlorine Atom	Sour Mash (Distilleries)
Crescents	Sulfur Chloride
Crude Oil	Sulfuric Acid—5% 80°F.
Cyanides	Sulfuric Acid 10% 80°F.
Dye—Black Sulfur	Sulfuric Acid—25% 80°F.
Dye—other (except Chromes)	Sulfuric Acid—70% 80°F.
Ethyl Alcohol	Sulfuric Acid—70% 90°F.
Ethyl Acetate	Sulfuric Acid—25% 100°F.
Ethyl Chloride	Sulfuric Acid—10% 150°F.
Fatty Acids (Adulterated)	Sulfuric Acid—25% 150°F.
Fruit Juices	Sulfuric Acid—30% 150°F.
Fuel Oil	Sulfuric Acid—70% 150°F.
Garbage Liquor	Tankage (highly acidic)
Gasoline (Sew)	Trichloroethylene (solvent)
Glycols	Terpentine
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Hydrogen Sulfide	Water-Alkaline Tap Waters
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*Reg. T/M of The I. Co.

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Fig. 1839-3
and
Fig. 1847-4



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YOU AND YOUR JOB, cont. . .

mentally by dividing successively by three.

Example 2: Water is run into an agitated 1,000 gal. tank of methanol with an overflow at the 1,000 gal. level. What will be the methanol concentration after 1,000 gal. of water has been added?

Ans.: 37 percent methanol.

Example 3: A piece of steel at 100 deg. C. was observed to cool to 95 deg. C. in 5 min. in 25 deg. C. air. How long will it take to cool to 30 deg. C. (temperature difference is disappearing at a rate proportional to the temperature difference).

Ans.: Initial cooling rate = 1 deg. C. per min. Linear time to 25 deg. C. = 75 min. In 75 min. will actually cool to 25 deg. +0.37 (100-25) = 53 deg. C.

In 150 min. will cool to 25 + 0.37 (53-25) = 35 deg. C.

In 225 min. will cool to 25 + 0.37 (35-25) = 28.7 deg. C. Call it 200 min.

This rule can also be applied to radioactive decay, washing problems, purging problems and many others. If the rule is used several times, the engineer soon develops an ability to recognize situations where it may be applied.

Along with his quick methods, an engineer in research should develop a bag of tricks—unconventional ways to do things quickly and cheaply where time is more important than operating cost. For example: a proposed process requires hot water at 150 psi.

The assembling of the conventional pump, motor, heat exchanger, and piping might take weeks or even months before experimental evaluation could begin. An engineer in research would look for some way to beat the rap. He might for example, strip the insulation from a run of overhead high pressure steam line and take hot condensate from the low end. The preliminary data might properly result in abandoning the proposed process before the purchase requisitions for conventional equipment could have been processed. The decks would then be clear and ready for the next idea. Yet what design engineer would consider condensing steam for hot water?

Instrumentation, although vital in operating plants, might often be profitably avoided in the early stages of the development by practices normally considered wasteful.

LEARN TO BE RESOURCEFUL

An engineer in research should cultivate his inventive talent. A few hours of thought can save weeks or more in

Cleveland Electric
Illuminating Company reports on
Westinghouse Metal-Clad Switchgear...



"Keeps Maintenance Cost Down!"

At the Cleveland Electric Illuminating Company's Ridge Road Substation, this installation of Westinghouse Metal-Clad Switchgear is setting an excellent service record. And what they say about it suggests a savings opportunity for you:

"We particularly like its low maintenance characteristics. In two years of operation, there has been a minimum of inspection and maintenance. Expected result is an appreciable long-range saving."

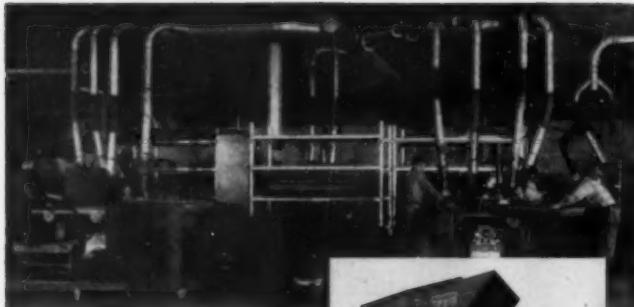
Some of the features contributing to this saving are easy accessibility to component parts, simple,

fast removal and replacement of draw-out air breakers, and exclusive "De-ion"® circuit interruption.

The complete story of the savings possibilities of Westinghouse Unitized, Metal-Clad Switchgear is contained in Booklet B-4016. For your copy write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-60767

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SWITCHGEAR**



Exhaust heads and piping, engineered to fit the job, capture dust particles at the source, before they can escape to cause trouble and cost money.



Clean-up at Pangborn Collector showing special dust removing dust storage bin, and eliminating the charge duct.

Pangborn presents Woodall* with "DUST to BURN!"

*How Woodall Industries, Inc., uses Pangborn equipment to save \$14,000 per year!

Woodall Industries, Inc., Long Island, N. Y., produces Masonite panels in varying shapes and sizes for the automotive, railroad, television, and refrigeration industries, to name just a few. Shaping and drilling these panels produces Masonite dust—and plenty of it!

Without an effective system of dust control, Woodall workers would soon be knee-deep in dust. Thus, the Pangborn Dust Control System installed at Woodall would be essential at any cost. The beauty of the system, however, is that it doesn't cost at all—but actually pays its own way, with a nice profit to boot!

That's because this Pangborn Dust Control System not only

maintains a dust-free plant, but also provides all the fuel for all heating and processing requirements, by conveying the Masonite dust from its source to a boiler furnace. Savings in oil alone have been figured at about \$14,000 a year!

Add to this the savings in "house-keeping" costs, benefits in improved health and morale of employees—and you can see why Woodall is so enthusiastic about their Pangborn Dust Control System.

What are your Dust Problems?
Find out what Pangborn can do to solve them. Write today for Bulletin 909A. Address: PANGBORN CORPORATION, 2600 Pangborn Blvd., Hagerstown, Md.

*Look to Pangborn for the latest developments in
Dust Control and Blast Cleaning equipment*

Pangborn
DUST
CONTROL
STOPS THE DUST HOG from stealing profits

You & Your Job, cont. . .

the laboratory or the pilot plant. For example: It was desired to determine roughly the vapor pressure of a certain inorganic material which was believed to boil at about 1,700 deg. C. After considering and discarding a number of proposed methods as hopeless or time consuming, a simple idea evolved. A small piece of material was placed in the sealed end of a $\frac{1}{4}$ in. silica tube. The open end of the tube was connected to a vacuum pump and the sample degassed at red heat. The tube was then sealed off with an oxy-hydrogen torch, leaving the sample in a silica capsule with a long handle. Using the same torch, the capsule was heated while an assistant observed with an optical pyrometer. At about 1,700 deg. C. the silica capsule softened and collapsed. The blob of viscous silica was kept in the flame by slowly rotating the handle. At about 1,900 deg. C. the blob expanded into a cellular mass. This simple experiment was conceived and executed in one day. It may have saved several man months.

An engineer is always an economist, a man who can do for one dollar what anyone can do for five. A chemical engineer in research must deal with two economies. He must guide his work by the economic laws governing the supply and demand for chemical products, but he must perform his work while observing the economic facts of life of the research laboratory. He should extend his quick calculating methods to include a few to help him rough out the size of a market, the cost of his proposed plant and product, and the time required to develop them.

BE A GENERAL PRACTITIONER

Just one more point before leaving the subject. Insofar as possible, the engineer in research should cultivate self sufficiency. He should not court delay by relying heavily on consultants or specialists to help him solve his day-to-day problems.

Large companies usually have a battery of specialists available to assist the younger engineers. Their services are unquestionably valuable, but they can be misused by engineers in research. Such an engineer should use specialist services to help guide his long-range thinking and to educate himself so that he may handle his routine problems quickly. Only rarely can a consultant help save time on a routine problem. Generally his viewpoint is that of the design engineer or operating supervisor. He is a busy man. Often when needed in a hurry, he may be found in a meeting, on vacation, consulting at the Saskatchewan

wan plant, or merely swamped with work. The engineer in research should be an on-the-spot general practitioner.

If the *modus operandi* suggested by the foregoing paragraphs seem rough and crude, the reader should realize that a research man must sift dozens or hundreds of ideas and proposals to find the few worthy of more extensive study. Unless he adopts such methods, he would become hopelessly mired in a morass of alternatives and sub-alternatives. The months could pass while his company's competitors forge ahead.

F. R. Bichowski, in his book "Industrial Research" makes the following statement, "The research man, if he is to be worth anything, must be able to find the grain of gold in the pan of gravel; the development engineer must be able to see the fly in the ointment." The development engineer in his example developed a mechanical product into a salable form. The engineer in research is first a research man. As the job takes form, he should consult with design men and specialists to whom he may eventually pass the ointment, flies and all.

To the research-minded reader, these thoughts must certainly seem trite. Yet years actually pass before a research man with chemical engineering training and indoctrination, would instinctively agree that in research, engineering is a kit of tools, not a career.

—End

Invitation

With this month's publication, You and Your Job completes its first year of service to you, the engineer—not as a technical man, nor a cog in a wheel, but rather as a pretty important human being. A human being, to borrow from Shakespeare, with eyes, ears, feelings, passions . . .

Don't misunderstand. This is not our swan song. Your enthusiastic reception to the series prompts us to hope for 20 more years like the last.

You can help even more. We'll continue to look forward to your comments—in letters, personal conversations, or remarks on the continuing readership surveys that go to 1,000 of you each month.

We value these criticisms very highly, whether they are like the cryptic one word "Bunk!" that we once received or friendly words of praise.

Your suggestions on subject matter, presentation or anything else, are welcome, respected, requested.

So, if we haven't gotten to your pet subject yet, why not catalyze the reaction by telling us what you'd like to see and why you'd like to see it.

Do you want to join our fast-growing alumni of authors? Drop us a line and let's discuss it.

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75th Anniversary Emblem: 1877-1952

Names in the News

Edited by Frances Arne



MAN OF THE MONTH: Foster D. Snell

Winner of the Fourth Annual Honor Scroll Award of the American Institute of Chemists, he heads his own New York firm of consulting chemists.

There's no mystery in how Foster D. Snell, Inc., chemical consultants, grew from a one-man operation to one employing over 100 persons. Even a brief look at the personal qualities of its scientist-businessman founder makes the solution quite plain.

Foster Snell could have been the original model for the adage "Hard work never hurt anyone." Since starting his firm in 1925 he's been keeping stride with a schedule that

looks impossible on paper. Yet when he came down with German measles in March, none of his associates could remember the last time he'd missed a day at the office.

On meeting him the dominant impression is of a man who knows where he's going and is optimistic about getting there. As a chemist, an executive and in his personal life, he is basically an organizer. He attacks each job early and methodically, whether discovering the factors in detergency, writing technical books or navigating his 33-ft. cabin cruiser.

The lab coat Snell usually wears during office hours betrays his preference for research over administrative work. He has arranged things so that as little as possible of his time is spent on the business details of his organization.

He also has arranged to find time for activity in professional committee work and for boating and bridge.

As for the committee work, he is past president of the American Institute of Chemists, a member of the council policy committee of ACS, a former vice president of the American Oil Chemists Society, a past vice president of the Society of Chemical Industry (he received their Gold Medal in 1949), a committee chairman of the National Research Council, president of the International Fat and Oil Commission of the Union of Pure and Applied Chemistry, treasurer of the Assn. of Consulting Chemists and Chemical Engineers.

As for boating, he buys boats and turns them in as regularly as other people do cars. To him the pastime offers both a peaceful retreat and a challenge. Docking in Tarrytown, N. Y., he does a good bit of cruising on the nearby Hudson.

Playing bridge gives Snell an outlet for his gambling instinct. Once a tournament player, he now gets more fun out of playing an interesting and difficult hand and going down 3 or 4 tricks than he does in making a perfectly bid contract.

John D. Coleman. President, National Society of Professional Engineers. Supervisor, material utilization, Frigidaire Division, General Motors Corp. Chemical engineering graduate of the University of West Virginia.

Richard C. Ruffer. Manager of American Cyanamid's Valdosta, Ga., plant. For the past two years, manager of the company's Woodbridge, N. J., plant. Before that, manager of its Kalamazoo, Mich., plant. Prior to joining Cyanamid in 1942, technical service assistant with the Mead Corp., Chillicothe, Ohio. Ohio State graduate.

W. R. Allstetter. Vice president of the National Fertilizer Assn. Previously with the Dept. of Agriculture as deputy director of the Office of Materials and facilities in charge of fertilizer and agricultural chemical programs. First joined the Dept. of

Agriculture in 1942. Studied chemistry and physics at Swarthmore College; attended Yale Law School.

Charles W. Walton. President, Commercial Chemical Development Assn. Manager, new products division, Minnesota Mining and Mfg. Co. New vice president-elect: Wayne E. Kuhn, manager of technical and research division, refining department, Texas Co.

W. T. Witter. Assistant to the development manager, Monsanto's foreign department. Has been an assistant production department supervisor in the company's John F. Queeny plant in St. Louis. With the company since 1946.

Elmer B. Vliet. Vice president and scientific administrator, Abbott Laboratories, North Chicago, Ill. Has been director of control since 1946. Started with Abbott as a re-

search chemist in 1919, made manager of the control laboratories in 1935. Studied at the University of Illinois.



E. B. Vliet



S. R. Bell

S. R. Bell. Principal engineer on synthetic resins and plastics, chemical plants division, Blaw-Knox. Graduate of the University of Pittsburgh.

Clarence L. Karl. Manager of AEC's Fernald (Ohio) Area which supervises construction and operation of the new feed materials production

for soaps and detergents

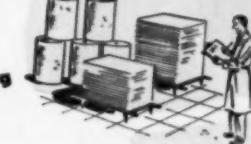


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As leading primary producers of Sodium Phosphates, Blockson has made substantial plant additions in its two factories to keep up with the increasing Sodium Phosphate demands of American Industry.

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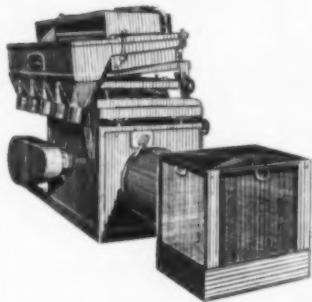
- Chlorinated Trisodium Phosphate
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NAMES IN THE NEWS, cont. . .

center being built there. Previously manager of the AEC's St. Louis Area, responsible for supervising construction and operation of uranium production plants at Mallinckrodt Chemical Works and elsewhere in the vicinity. His successor, J. Perry Morgan, formerly chief of the staff technical branch of the New York operations office production division.

Paul Nawiasky. Retired as associate manager of the process development department at General Aniline and Film's Grasselli (N. J.) plant. Joined Badische Anilin and Soda Fabrik, Germany, in 1907. Came to General Aniline in 1936 from a post as head of the Alizarine Laboratory at Ludwigshafen, Germany. Doctorate from the University of Berlin.

Robert C. Swain. Member of the board of directors, Stanford Research Institute. Vice president and director of research, American Cyanamid. Joined the company as a research chemist in 1934, became a research executive in 1937.

Harry I. Abboud. Transferred from Cabot Carbon Co.'s Ville Platte, La., plant to the position of assistant plant engineer at the company's new Canal plant near Franklin, La.

John P. Sachs. Chemical engineer, technical division staff, Visking Corp. Doctorate from Illinois Institute of Technology. Other new chemical engineers: David B. Speed, Ohio State; James E. Stice, Illinois Institute of Technology; Elio M. Tarika, formerly with Colgate-Palmolive-Peet.

Fred Ebersole. From production control manager at General Aniline & Film Corp.'s Grasselli, N. J., plant to the newly created position of product line and inventory control manager. Joined the company 21 years ago as assistant production chemist at its Rensselaer, N. Y., plant. Later, production chemist in charge of the intermediates department; section leader of the process development department, 1942; transferred to the Grasselli plant in 1944 as assistant to the manager of process development. His successor as Grasselli production control manager: Francis Charles, formerly supervisor of production planning and control. Joined General Aniline two years ago coming from Plume and Atwood Mfg. Co. where he had been production control manager.

Zay Jeffries, E. K. Bolton and J. R. Townsend. Members of the recently-formed committee on materials of the Dept. of Defense research and development board. Dr. Jeffries: a former vice president of



FIRST ARMY CERTIFICATE OF ACHIEVEMENT

Colonel Martin B. Chittick, right, has been awarded the First Army Certificate of Achievement for his exceptionally meritorious and faithful service during the period from August 1949 to May 1952. Commanding officer and founder of the 1966th Organized Research and Development Unit, New York, he is retiring after 32 years in the Army and organized Reserve Corps. He is associated with American Mineral Products Co. Presenting the award is Colonel H. A. Cooney, Chief of N.Y.M.D.

*Permutit Research in Ion Exchange Produces
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99.99995% PURE WATER

WITHOUT DISTILLATION!

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Reduction of electrolytes to less than 0.2 ppm (specific resistance approximately one million ohms-cm) and silica to less than 0.05 ppm is readily obtainable. In actual practice, specific resistance as high as 24 million ohms-cm has been achieved. Purity of Permutit Mixed Bed Demineralized water exceeds ASTM requirements by over one full decimal place. By comparison, most commercial distilled water contains from 2 to 10 ppm electrolytes. Yet the cost of distillation far exceeds that of Mixed Bed Demineralizing for most normal water supplies, requires more time, and uses equipment that takes up far more valuable space.

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In the Mixed Bed Demineralizer, Permutit has developed equipment to produce water with total electrolytes less than 0.2 ppm, silica below 0.05 ppm. It is a single unit ion exchanger containing both anion and cation exchange resins in a homogeneous mixture. In one single stage, many separate demineralizing steps are provided, so that mineral impurities reach the vanishing point. The residual content is so low that conventional methods of analysis cannot be used for accurate determination, and conductivity measurements are customarily used. The types of ion exchangers—both anion and cation—can be varied to meet individual requirements for which the Mixed Bed Demineralizer is used. Through such variation, the Demineralizer can be applied to many different uses. The latest development by Permutit is *fully automatic control!*

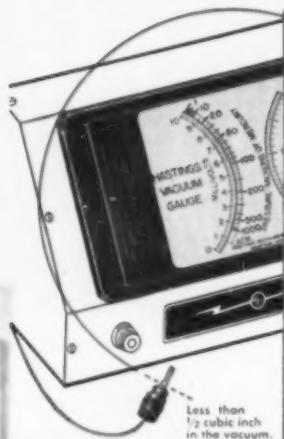
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The stability and wide range of this gauge (1 to 1000 microns) makes it extremely suitable for both laboratory and production use in vacuum tube manufacture, distillation, automatic exhaust machines, dehydration and refrigerator servicing. Its rapid response to pressure changes makes it especially suitable for leak detection, warning devices and pressure operated controls.

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NAMES IN THE NEWS, cont. . .

GE recently named a vice chairman of the minerals and metals advisory board of the National Academy of Sciences. Dr. Bolton: retired chemical director of Du Pont. Mr. Townsend: materials engineer for Bell Telephone Laboratories who has been serving the Office of Defense Mobilization as consultant to the director on conservation of materials. New deputy chairman of the committee on materials: H. F. Robertson.

Judson Sweatingen. Director of petroleum technology, Southwest Research Institute, San Antonio, Tex. Has been chairman of chemical engineering since the institute's founding in 1947. Previous to that, consulting chemical engineer in New York.



J. Sweatingen



T. E. Lindsey

Ernest T. Lindsey. Manager of the Bishop, Tex., chemical plant of Celanese Corp. of America.

Charles F. McKenna, Jr. Has established an office in Washington, D. C., to represent industrial groups operating in the chemical and chemical process industries. For the past year, Washington representative for all divisions of General Aniline & Film Corp. With General Aniline since 1945. Previously with Commercial Solvents for 17 years in the market developing and sales departments.

J. S. Beecher. In charge of proposals and general technical work, Power Chemicals Division, E. F. Drew & Co., New York. New assistant to Mr. Beecher, Charles Clodi, also in charge of the water laboratory.

Abbott K. Hamilton. In charge of product divisions, Commercial Solvents. Also a vice president. With the company since 1946.

G. Donald Campbell. Superintendent, Pittsburg Plate Glass Co.'s Shelbyville, Ind., fiber glass manufacturing plant. Previously, assistant superintendent at the Clarksburg, W. Va., window glass plant.

With the company since 1930, first as a chemist, later as a research engineer. New plant engineer at Shelbyville; John A. McMillan. For the past five years, plant engineer for Duplate Canada, Ltd.



G. D. Campbell



R. D. Waters

Richard D. Waters. From assistant general manager to vice president, Vick Products, Vick Chemical Co. Joined the company in 1936. Princeton graduate.

Yves-Rene Naves. Winner of the 1952 Gold Medal-\$1,000 Fritzsche Award presented by ACS. With the research laboratories of Givaudan et Cie, Geneva, Switzerland.

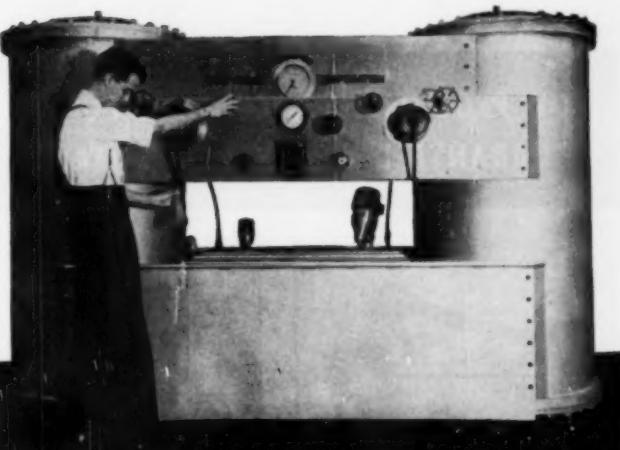
I. R. Hollenberg. President of Van Dyk & Co., Belleville, N. J. For the past three years, executive vice president and general manager. Joined the company in 1935 as a chemist.

E. A. Meilun. Sales engineer in the New York office of the Bufflovak Division of Blaw-Knox. Associated with Bufflovak for four years. Has been in the engineering department working on: development, design, estimating. From 1945 to 1947, with GE as a chemical engineer in the phenol plant at Pittsfield, Mass. Chemical engineering graduate of Clarkson College.

M. W. Burkhart. General manager, Lincoln Plastics Corp., Cambridge, Ohio. Former employers: Cambridge Molded Plastics Co., plastics division of Continental Can; Reynolds Spring Co., Newark Plastics, General Motors. New chief engineer: L. M. Wuest. For the past six years, chief engineer, Standard Products Co.

Charles S. Munson. New director and member of the executive committee of Penick & Ford, Ltd. Also chairman of the board of Air Reduction Co. and the Manufacturing Chemists' Assn.

Alexander Pechman. To staff of Ryan Aeronautical Co. development laboratories, San Diego, Calif. He will specialize in Ryan's program of test-



A "PACKAGE UNIT" DEMINERALIZER

Cochrane Demineralizers produce the equivalent of distilled water for industrial application at a mere fraction of the cost of commercially distilled water

THE Cochrane Model CDM Demineralizer is a self contained unit complete with reaction tanks, chemical tanks, special piping and all necessary accessories. Only ordinary piping and electrical connections are required to complete your installation.

The unit is designed so that all steps of operation are performed and all results observed from a position in front of a panel. Chemical tanks are also

changed from this position, making the unit suitable for location against a wall or in a corner. All control valves are located on the panel at eye-level. The exteriors of all components of the unit are coated with a baked plastic finish preventing corrosion of exterior surfaces due to splashing or presence of corrosive atmospheres and providing a pleasing appearance, thus encouraging the operator to keep the equipment and the operating area clean.

OPERATION AND CONTROLS

- 1 Two multiport single-lever valves control backwash, regeneration, rinse and treating for each reaction tank.
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- 3 A pressure gauge in raw water line indicates water pressure available at all times.
- 4 A flow meter in the effluent line continuously indicates quantity of water which may be treated before regeneration.
- 5 Electric switches for control of either agitator are on panel.
- 6 Valves to divert water to conductivity cell or sampling valve are provided.
- 7 Valves for controlling admission of regenerating solution to reaction tanks or water to refill chemical tanks are provided.

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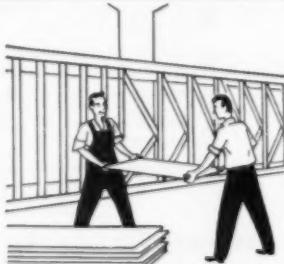
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Having kept close touch with research and preliminary engineering the sales engineer will present recommendations to you. Together you will discuss these in terms of meeting your specific requirements.



Once your order is placed the equipment will be designed in exact detail so that the finished machine will meet your individual requirements — and perform exactly as guaranteed in the sales agreement.



Intelligent interpretation of plans on the part of the Proctor men who build your equipment is the final touch to producing the finest possible equipment—engineered and built to meet your individual requirements.

PROCTOR & SCHWARTZ, INC.

711 TABOR ROAD • PHILADELPHIA 20, PA.

NAMES IN THE NEWS, cont. . .

ing and improving ceramic coatings for jet, rocket and internal combustion engines.

Victor A. Hann. Executive vice president, Welsbach Corp., Philadelphia. Has been director of the ozone processes division. With the company since 1938.



V. A. Hann



W. H. Roberts, Jr.

William H. Roberts, Jr. Vice president in charge of operation, Glyco Products Co., Brooklyn, N. Y. With Glyco since 1947 as general plant manager. Previously connected with Hooker Electrochemical Co. and with E. R. Squibb in charge of streptomycin plant design and in penicillin production. Studied at MIT and Harvard.

James K. Stanley. From senior projects metallurgist to section head in the materials division of the engineering research department, Standard Oil Co. (Indiana). Came to Standard in 1950 after 13 years with Westinghouse Electric Research laboratories as research metallurgist. Studied at Case Institute of Technology and the University of Pittsburgh.

Edward P. Gilheany. Patent counsel, Chemstrand Corp. For the past ten years, assistant patent counsel for General Aniline & Film Corp. Studied chemical engineering at Villanova, law at Georgetown and DePaul. New patent attorney: **Roy P. Wymbs.** Formerly in a similar capacity with American Viscose Corp. Studied chemistry at the University of Richmond, law at George Washington University.

Samuel Colville Lind. Winner of the Priestley Medal awarded by ACS. Dean emeritus of the University of Minnesota Institute of Technology, he is at Oak Ridge as research consultant on the staff of Carbide and Carbon Chemicals Co. which operates the laboratory and two atomic energy production plants there. On the faculty of the University of Michigan, 1905 to 1915; Bureau of Mines chemist specializing in radioactivity, then chief chemist; director



Meet the
First Two Victims
of
Systox

A REVOLUTIONARY NEW INSECT KILLER!

SYSTOX, a revolutionary new type of insecticide, has just been approved for the control of aphid and two-spotted spider mite on cotton. Unchecked, these killers could destroy the nation's cotton crop.

SYSTOX is the first true *systemic* insecticide ever approved for use in this country. Its dramatic method of control promises enormous new benefit to American agriculture. Absorbed and translocated through foliage and roots, **SYSTOX** renders plants highly toxic to many destructive insects for a considerable period of time.

Approval of **SYSTOX** for controlling these cotton insects climaxes three years of intensive research by the Pittsburgh Agricultural Chemical Company and its associate, Chemagro Corp., following its original development by Farbenfabriken Bayer, Germany. Results of this work indicate that **SYSTOX** . . . renders most plants toxic to insects three to four times longer than conventional insecticides.

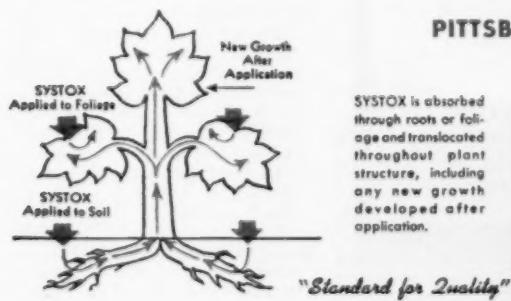
. . . is effective when applied in doses as small as one ounce of pure **SYSTOX** per acre.

. . . can be effectively applied to seeds before planting, thus protecting the young plants for a considerable period.

SYSTOX also appears to be effective in controlling many common insects which attack fruits, vegetables, grains, forage crops, sugar and tobacco, and its ultimate use on these crops is indicated. Research also indicates that only harmless traces of **SYSTOX** residue—measured in tenths of parts-per-million—remain in the harvested crops.

Approval for the initial use of this amazing new insect killer marks a significant milestone in the fight of this nation's great agricultural and chemical industries against destructive insects.

*Because of its vital importance, we are immediately making **SYSTOX** available to cotton growers in commercial quantities through our established outlets. **SYSTOX** will also be available to research organizations for experimental use on other crops.*



SYSTOX is absorbed through roots or foliage and translocated throughout plant structure, including any new growth developed after application.

PITTSBURGH AGRICULTURAL CHEMICAL CO.

Empire State Building, New York, N. Y.

WBC 4209



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COKE & CHEMICAL CO.**

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equipment

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or green plastic
visors

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less than
an ounce!

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WILLSON PRODUCTS, Inc., 106 Thorn Street, Reading, Pennsylvania

NAMES IN THE NEWS, cont. . .

of the Dept. of Agriculture's fixed nitrogen research laboratory, 1925; joined the faculty of the University of Minnesota where he stayed until 1947. President of the Electrochemical Society, 1927; president of ACS, 1940.

Kay B. Sebert. Chief chemist at the Java plant of Goodyear Tire & Rubber Co. A member of the mechanical goods compound development department since 1950. Joined the company in 1947. Iowa State College graduate.



K. B. Sebert



A. P. Super

Albert P. Super. Research engineer, special applications department, Permutit Co., New York. Previously, a chemical engineer in the technical department at the Radford, Va., arsenal of Hercules Powder Co. Graduate of Virginia Polytechnic Institute.

Kenneth C. Towe. New director of the Manufacturing Chemists' Assn. President of American Cyanamid.

J. A. Sherrard. Development director, Monsanto Chemical Co.'s Texas division. With the company since 1947. Studied at Balliol College, Oxford University. New sales development manager for the division: **F. Faxon Ogden**, formerly a member of the company's general development department in St. Louis. Joined Monsanto in 1935 as a research chemist. Cornell graduate.

D. G. Calkins. In charge of the new radiochemistry department, Industrial Nucleonics Corp., Columbus, Ohio. Formerly, associated with the AEC at Oak Ridge in radiochemical research, then on the staff of the Battelle Memorial Institute where he was an assistant supervisor in charge of radiochemical research. Studied at Wayne University and the University of Pittsburgh.

Kuang Lu Cheng. Microanalyst, analytical department, Commercial Solvent's research and development division in Terre Haute, Ind. Previously a chemist at the University of

Illinois where he received his PhD last year.

A. P. Frame. Resumes his offices as president of Cities Service Research and Development Co., and vice president of the Cities Service Refining Corp. and Cit-Con Oil Corp. He has been on loan for eighteen months to the Petroleum Administration for Defense in Washington, D. C. In addition, he has just been elected first vice president of Cities Service Petroleum, Inc., the coordinating company for the petroleum operations of the Cities Service organization.

Wilma M. Vogt. Chemist in the development and research department, Hooker Electrochemical Co. New chemist in the works laboratory: **Frank L. Echelberger.**

D. H. McCondichie. Plant manager of the Merck & Co. plant to be built at Flint River. Joined Merck's industrial engineering department as senior standards engineer in 1951. Chemical engineering graduate of the University of Alabama. New plant engineer and assistant plant manager at the Stonewall plant: **Herbert E. Silcox.** Joined Merck as a chemical engineer in the process development department in 1942. Doctorate in chemical engineering from the University of Illinois.



D. E. Cordier



H. A. Hoppens

David E. Cordier. Director of research, Plaskon Division, Libbey-Owens-Ford Glass Co. Formerly, associate director of research. With the company since 1933 working on research and development on plastic molding compounds. Purdue graduate. **Harold A. Hoppens:** from associate director of research to director of technical service. With Plaskon for ten years specializing in research and technical service work on coating resins. Doctorate from the State University of Iowa.

Sanford E. Glick. Assistant sales manager of thermoplastic molding materials, Monsanto's plastics division. Joined the company in 1941 as a research chemist; in 1946, manager of technical service on thermoplastic

PLATECOILS
REPLACE PIPE COILS

cut costs again

**SAVE
5 WAYS**

In this DAUER SPENT
BONDERITE SYSTEM

The C. A. Dauer Co., Detroit, Michigan, has found they get more efficient heat transfer at lower cost when they equip their bonderite systems with Platecoils. Use of Platecoils has these five advantages:

- Lower first cost.**
- Simplified and less costly installation.**
- Takes less space in tank.**
- Higher heat transfer rate.**
- No pipe joints in solution.**

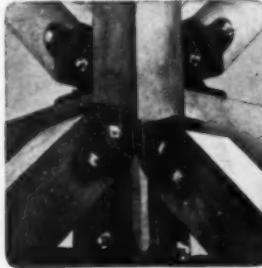
The 5-Stage Dauer Bonderite Washer pictured above has Platecoils in all five stages. It has electro-polished stainless steel Platecoils in the Bonderite stage and cold rolled steel Platecoils in the other four stages. Because the Platecoils have so much greater prime surface in a given area, smaller size Platecoils can be used. As a result, the initial cost is less, tank capacity is increased and installation is simplified. The Platecoils are easily installed, using simple supports instead of the complicated racks needed for pipe coils. As there are no threaded joints in the solution, the Platecoils are much easier for Dauer's customers to remove for cleaning or repairs. They can be removed and replaced without dumping the solution. Why continue to use costly pipe coils when Platecoils heat or cool so much more efficiently at but a fraction of the cost? Send for bulletin P61 today.

PLATECOILS for TANK HEATING and COOLING

PLATECOIL
KOLD-HOLD MFG. CO.
DETROIT, MICHIGAN

greatest structural strength...

with WCEC
Patented Cast Iron
Timber Connectors



By use of WCEC connectors, the struts develop their strength as a column by direct bearing on the square end of the strut against a cast iron seat. The connectors spread the horizontal component of the stress in the strut over a large area of the vertical columns, to assure that the allowable resistance of the wood in compression perpendicular to the grain will not be exceeded. The vertical component of the stress is transferred to the vertical column in direct end grain bearing, through shear bars on the timber connector. These patented connectors develop the greatest structural strength of the timber joints, an accomplishment almost impossible to achieve by bolting alone. WCEC cooling towers directly in the path of hurricanes have withstood the test of extreme wind load without damage.



Typical installation at Bloomingdale's, New York City. Other WCEC towers at Gimbel Brothers, Pittsburgh; Scruggs-Vandervoort-Barney, St. Louis; Sears-Roebuck, Chicago; J. C. Penney Co., St. Louis.

WATER COOLING EQUIPMENT COMPANY

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Fabricating Plants: St. Louis, Mo. • Arcata, Calif. • Houston, Texas

REPRESENTATIVES IN TWENTY-EIGHT PRINCIPAL CITIES

NAMES IN THE NEWS, cont. . .

molding materials. Studied chemical engineering at MIT.



R. C. Scott



G. W. Walther

Robert C. Scott. Supervisor of agricultural chemical research, Pittsburgh Coke & Chemical Co. Before joining the company in 1950, he was a research chemist for Wallace Laboratories. Doctorate in organic chemistry from Syracuse University. New general superintendent of chemical operations at the company's Neville Island plant: **George S. Walther.** With the company since 1942 in its research and development and chemical operations departments. Chemical engineering graduate of the University of Pittsburgh.

Elmer F. Hinner and Paul Mayfield. New board members, Hercules Powder Co. Mr. Hinner: general manager of the company's department manufacturing chemical cotton; with the company since 1927. Mr. Mayfield: general manager of the company's terpene and rosin chemicals operations; with the company for 27 years.

OBITUARIES

Bourdon W. Scribner, 67, chief of the paper section of the National Bureau of Standards for 29 years, died March 5. In 1945, he was the recipient of the gold medal award of the Technical Assn. of the Pulp and Paper Industry for outstanding contributions to the technical advancement of the pulp and paper industry.

Gabriel Haas Schoen, 50, president of Schoen Bros., Inc., and POM Chemical Industries, died in Atlanta, Ga., March 20. He was a graduate of Georgia Tech.

Francis Mills Turner, 61, vice president of Reinhold Publishing Corp., New York, died in Manhattan, N. Y., April 3. Mr. Turner started his career as a research chemist with Vanadium Corp. of America. He was a graduate of the University of Toronto.



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Your North American tank car works day in and day out, year after year, never stopping but to load and unload your products and for maintenance. Here's truly a business partner worth many times its keep . . . the strongest member of any chemical shipper's team. And today, with a critical shortage of specialized tank cars, your North American partner is working harder than ever . . . keeping on the go every possible minute to meet the tremendous demands of the growing chemical industry. Remember—on the rails and in its offices, North American is your partner for fast, economical transportation and helpful, experienced shipping advice.

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INDUSTRIAL NOTES

NEW FACILITIES



Glyco Products Co.—A plant in Williamsport, Pa., to provide for diversification and expansion, primarily for civilian markets. Manufacturing of some products will begin in August. Much of the output of the company's older plant in Natrium, W. Va., is for defense purposes.

Shell Oil Co.—A 52,000 bbl.-a-day distillation unit at its Wilmington, Calif., refinery which will boost the plant's capacity some 20,000 bbl. per day when it goes into operation early in 1954. Shell will also install a new distillation column at its other West Coast refinery at Martinez, Calif., boosting that plant's crude distilling capacity by 5,000 bbl. per day. Both moves are part of a nation-wide expansion program that will cost \$100 million, add 4 million gallons daily to the company's output.

Allis-Chalmers Mfg. Co.—A newly organized apparatus department to further integrate related lines of products. The new department will take in both the old Texrope drive and pump departments.

Thurston Chemical Co.—A fourth fertilizer plant. This one is in Trenton, Mo. The company already operates plants in Joplin, Mo., Tulsa, Okla., and Lawrence, Kans. The new plant will have an annual capacity of about 25,000 tons a year bringing total capacity to 275,000 tons.

Union Rubber Co.—A \$275,000 plant in Oakland, Calif., for manufacture of tire treads and materials used in recapping.

General Petroleum Corp.—A \$500,000 engineering building at its Torrance, Calif., refinery. Ground has been broken for the new structure which will house 131 engineering and administrative personnel. Reason for the Torrance location is

that the growth of the Torrance refinery occupies most of the time and efforts of the engineering staff.

National Research Corp.—A \$600,000 plant in Newton, Mass., to engineer, design and fabricate its specialized process equipment for use in the chemical, metallurgical, electronic and coating industries.

Industrial Nucleonics Corp.—A research and engineering building in Columbus, Ohio.

Corning Glass Works, New York—A sales district office in Washington, D. C., headed by Charles L. Day.

Pittsburgh Plate Glass Co.—A Baltimore, Md., plant for the manufacture of industrial brushes.

American Mineral Spirits Co., New York—An office in Jackson, Miss., to serve accounts in that area in the rapidly growing field of extraction, particularly cottonseed oil. Thomas has been made manager of the company's new Mid-South territory.

U. S. Bureau of Mines—An experimental station to be built at Morgantown, W. Va., where research in the production of synthesis gas will be conducted as part of the Dept. of the Interior's studies of synthetic liquid fuels methods utilizing coal and other products.

Thomas A. Edison, Inc.—A \$500,000 laboratory to be completed in ten months at West Orange, N. J. Work there will be in the fields of storage and primary batteries, electrical instruments.

B. F. Goodrich Rubber Co.—A \$2 million program to increase output of its Los Angeles plant by 20 percent. Construction will start during the third quarter of this year.

Hagan Corp.—A research and development laboratory at its Orrville, Ohio, plant. Its major function will be development and testing of combustion and process control instruments.

Mathieson Chemical Corp.—An anhydrous ammonia plant in Morgantown leased from the government for five years. Operation has just started up; output will be sold to

industry, agriculture and the government and will supply nitrogen for Mathieson's eastern fertilizer plants. The plant is capable of producing over 200,000 tons of ammonia and methanol per year.

Pacific Chemical Co., Pasco, Wash.—A \$5.75 million expansion program which will enable the company to produce an additional 18,100 tons of nitrogen annually. A certificate of necessity has just been granted by the DPA.

International Minerals & Chemical Corp.—A \$1.5 million addition to its main processing plant at San Jose, Calif. Company officials expect the new facilities to boost the output of monosodium glutamate by 66 percent. New processing facilities will be in operation by June, 1953.

Bemis Bro. Bag Co., St. Louis, Mo.—A research and development department to coordinate and extend the company's activities in package design. H. V. Kindseth will direct the department which is located in Minneapolis.

Scher Brothers, Clifton, N. J.—Increased laboratory facilities and equipment for more comprehensive research, development, testing and production of dyestuffs and textile finishes.

Monsanto Chemical Co.—A Twin Cities sales office in Minneapolis which will be headed by Arthur A. Hibbler.

Bjorksten Research Laboratories—A laboratory building at Madison, Wis., for its mining and metallurgical division staff.

Sylvania Electric Products—Facilities to meet the increasing demand for electronic tubes to be completed shortly at Woburn and Newton, Mass.

Bareco Oil Co., Tulsa, Okla.—Sales and service offices at Chicago under the direction of George W. Skinner.

John Powell & Co.—An insecticide plant in Omaha, Neb., for the manufacture of Parathion, DDT, 2,4-D formulations, toxaphene and Chlordane concentrates.

Financial Reports Prepared
Profit Estimates Carried Out
Operational Costs Reduced
Technical and Economic Surveys Conducted
Acquisitions and Expansions Recommended
Plants and Equipment Designed
Competitive Situations Studied
Markets Determined
New Applications Suggested
New Products Suggested and Developed

ARIES SERVICES TO THE CHEMICAL INDUSTRY

600 assignments

Completed SINCE 1946

In the fast-growing, highly competitive Chemical Process Industries, it is becoming more and more difficult for each manufacturer to keep abreast or ahead of his neighbor—using the know-how of his own staff alone.

A large part of the problem can be handed over to outside consultants—specialists in research, development, design and cost studies. They can handle these jobs more efficiently and economically than can the client himself, through techniques acquired over years of working on similar assignments for others.

R. S. Aries is just such a well-grounded consulting firm of engineers and economists. Today they are successfully completing an average of ten studies per month. Aries knows products, processes, markets, costs. The combined experience of the senior members totals over 250 years and ranges literally from acetic acid to zirconium.

To help you create a more profitable business, consult with R. S. Aries & Associates, Engineers and Economists.

Aries will accept only those assignments where their experience can supplement your own.



R. S. ARIES & ASSOCIATES

CHEMICAL ENGINEERS AND ECONOMISTS

400 MADISON AVENUE NEW YORK 7, N. Y.

NEW NAMES

Worthington Pump and Machinery Corp. has changed its name to Worthington Corp. Because of the company's wide diversification of products, officials believed that continued reference to pumps in the corporate name was misleading.

Nashua Gummed and Coated Paper Co., Nashua, N. H., has shortened its name to Nashua Corp.

NEW LOCATIONS

Barrington Engineering Corp., manufacturer of high speed wet mixing equipment of the turbine type, has moved its executive and sales office to 110 West 40th St., New York.

Blaw-Knox Co. has moved the headquarters of its fastest growing unit, the chemical plants division, to a new building at Duquesne Way and Garrison Pl., Pittsburgh, Pa.

Aula Chemicals, Inc., manufacturer of textile and allied printing colors, has moved to 714 Division St., Elizabeth, N. J.

NEW COMPANIES

Kath Development & Mfg. Co., Cleveland, to originate new and improved pharmaceutical manufacturing and packaging machinery. A. W. Kath, formerly with Eli Lilly, heads up the company, a subsidiary of Strong, Cobb & Co.

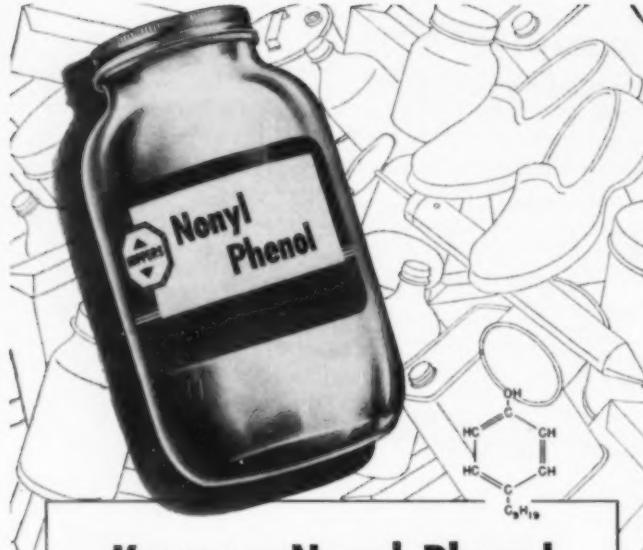
Tech-Industry Services, New York, to provide industrial public relations service. The company is headed by Harold Schor.

Chemical Construction (Inter-American) Ltd., Toronto, Canada, a subsidiary of American Cyanamid, to design and build chemical plants in all nations of the Western Hemisphere except the U. S.

Harbison-Walker Minerals, Ltda., a subsidiary of Harbison-Walker Refractories Co., to develop sources of raw materials in Brazil.

Labline, Inc., Chicago, to manufacture laboratory apparatus, instruments and equipment.

Stauffer Panamerican Co., a wholly-owned subsidiary of Stauffer Chemical, to handle all the parent company's export sales in the western hemisphere. Offices are being established in several of the prin-



Koppers Nonyl Phenol

One of a Series of Koppers Alkylated Phenols

Suggested for use in the production of a number of chemical products which require a mono-alkylated phenol of relatively high boiling point and molecular weight.

The properties of Nonyl Phenol indicate usefulness in the production of detergents, modified phenolic resins, non-ionic surface active agents, dispersing agents and wetting agents, lubricating oil additives and corrosion inhibitors, rubber chemicals, plasticizers, plastic stabilizers, germicides, insecticides, fungicides, oil soluble resins, tanning agents, dyestuffs and pharmaceuticals.

KOPPERS NONYL PHENOL is produced in commercial quantities. It is a slightly viscous, clear liquid; only very slightly soluble in water, but miscible with common organic solvents.

REACTIONS

Two of the three normally reactive nuclear positions are unsubstituted in this alkylated phenol; they are

subject to such reactions as acylation, and condensation with aldehydes. It is a mixture of monononyl phenols, predominantly substituted in the para-position.

The unhindered phenolic hydroxyl group undergoes such reactions as etherification, esterification, vinylation, ethylene oxide condensation, and formation of nonyl-phenoxyacetic acid.

PROPERTIES

Boiling Range.....	290°—300°C.
Hydroxyl Number (theory 255).....	250
Specific Gravity, 30°C.....	.940—.944
Refractive Index, 20°C.....	1.5118

FOR FURTHER INFORMATION
write to Koppers Co., Inc., Chemical Division

KOPPERS COMPANY, INC.
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Many of these installations
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Specialists in Equipment for All Low-Temperature Processes

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Specifically Designed
for WATER PRESSURE CONTROL

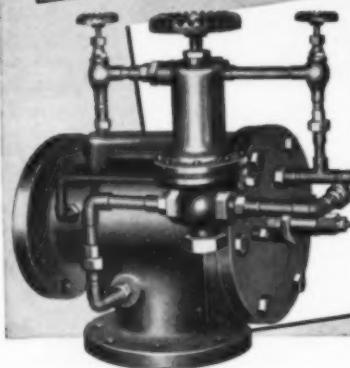
GOLDEN-ANDERSON CUSHIONED
WATER PRESSURE REDUCING VALVE

Used to protect water lines where high initial pressures would cause serious damage to distribution mains, this very sensitive valve will maintain a uniform delivery pressure. Bulletin W-3 will interest you.



GOLDEN-ANDERSON
CUSHIONED SURGE
RELIEF VALVE

This valve is used to protect water lines against excessive pressures caused by surges in the system, and will open immediately when inlet pressure exceeds the adjustment of the pilot. Bulletin W-2 sent on request.



For over 50 years, Golden-Anderson has specialized in designing and manufacturing pressure control valves. The patented air and water cushioning feature effectively prevents any bang or hammer.

May our experienced engineers help you with your water pressure control problem?

IMMEDIATE SHIPMENT
FROM STOCK ON
MANY SIZES.

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INDUSTRIAL NOTES, cont. . .

cipal cities throughout South and Central America and Canada.

Asahi-Dow Ltd., an associated company of Dow International and the Asahi Chemical Industry Co. of Osaka and Tokyo, to produce saran monomers and copolymers at Nobeoka on the island of Kyushu.

NEW REPRESENTATIVES

Metals Disintegrating Co., Elizabeth, N. J., has appointed August Hoffman Co., Indianapolis, as a distributor of its aluminum pastes and powders and gold bronze powders.

Diamond Alkali Co., Cleveland, has appointed M & L Supply Co., Akron, as distributor for its specialized laundry detergents, sours and blues in northern and central Ohio.

Lee Rubber & Tire Corp.'s Republic Rubber Division has appointed John Bouchard & Sons, Nashville, Tenn., as an accredited distributor.

Davison Chemical Corp., Baltimore, has appointed Kreckel-Goetz Sales and Supply Co., Grand Rapids, Mich., and Van Horn, Metz & Co., Philadelphia, as manufacturer's agents for its Sylloid 308 and associated products.

Ampco Metal, Inc., Milwaukee, has appointed Kirk-Wicklund and Co., Kansas City, Mo., as its distributor for the northern and eastern counties of Kansas.

Reynolds Metals Co., Louisville, Ky., has appointed two new distributors to handle its line of sheet, plate, wire, rod, bar, extruded shapes, tubing and pipe. They are: Vinson Supply Co., Dallas; Vory's Bros., Columbus, Ohio. A new distributor for its ingot products is G. A. Avril Smelting Corp., Cincinnati.

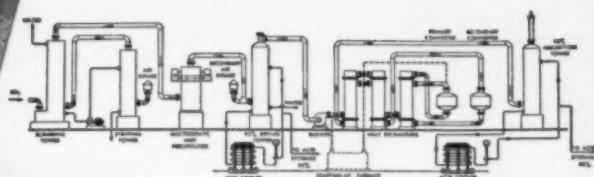
NEW LINES

Pennsalt of Washington—Alkaline cleaners and bottle washing compounds at its Portland, Ore., works. These products were formerly supplied to users in the West from the parent company works at Wyandotte, Mich.

Robert Gair Co., New York—The products of the former American Coating Mills Division of Owens-Illinois Glass Co. Gair recently acquired the division which will operate as a wholly-owned subsidiary called American Coating Mills Corp.

SO₂ up the stack....

**...wastes a
valuable source
of H₂SO₄**



You can produce much-needed sulfuric acid at a profit, if you have by-product sulfur dioxide in suitable quantity and strength from your chemical or smelting operations. The Chemico process, diagrammed above, or modified to suit specific conditions, provides a practical, efficient method for converting SO₂ into clean sulfuric acid. Chemico will design and construct the complete plant . . . deliver it in smooth-running operation on a performance-guaranteed basis. For specific recommendations, write us describing your problem fully.

This diagram shows how SO₂ gas is purified, dried, re-heated and converted into H₂SO₄ of any desired strength.

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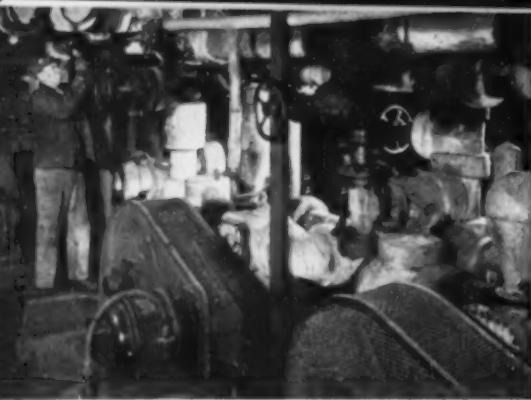
CABLES: CHEMICONST, NEW YORK

TECHNICAL REPRESENTATIVE IN EUROPE—CYANAMID PRODUCTS LTD., LONDON

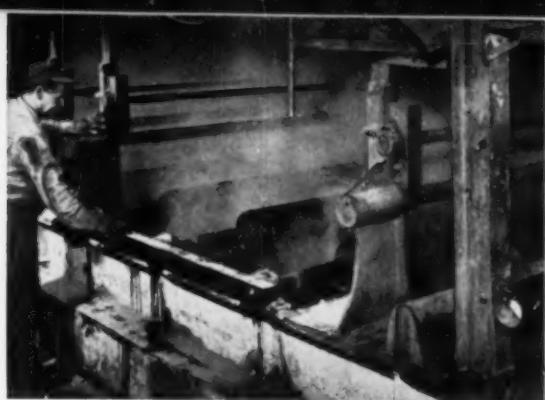
TECHNICAL REPRESENTATIVE IN SOUTHERN AFRICA—SOUTH AFRICA CYANAMID (PTY) LTD., JOHANNESBURG



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Quotes, Extracts and Digests

Edited by A. J. O'Brien, Jr.

1. COLLECT all waste data early.
2. STUDY conditions at plant site.
3. DRAW UP a disposal flowsheet.
4. CALCULATE capacities and sizes.
5. CUT pollution during start-up.
6. RUN a survey when operation begins.

Six-Step Plan for Abating Foul Air

Pollution is easier and cheaper to avoid than cure. All new processes and plants should be critically reviewed for waste disposal—successful pollution abatement begins and ends right here. This is the warning of C. A. Goshine, specialist of Du Pont's engineering department who spoke to the recent Air Pollution Abatement Conference at New York. His paper is the basis of this QED feature—Ed.

1. Collect All Waste Data Early: Plan for waste disposal in the research and pilot plant stage. As more and more products today take the big jump from the laboratory bench to the commercial plant, laboratory stages become vital for obtaining basic pollution data. At this point, chemical engineers on the research team, who know the problems of scale-up and the efficiencies of operating equipment, can furnish valuable data on waste.

Still further, study should begin early. Newer and more complex processes produce wastes with unknown characteristics. If you wait, you may have to neglect, or pay a high price for, adequate recovery, treatment or disposal.

During this step, obtain data on the characteristics of the wastes, operating conditions under which they are discharged, and the dispersion expected at the particular site.

Under characteristics of the wastes, determine:

1. Physical properties: Will they be fumes, dusts, mists or gases? If solids or mists, what will be the range of particle size?

2. Chemical properties: What absorbing or adsorbing agents could be used? Can they be reacted with other wastes before release? After release, will they react with other wastes in the atmosphere?

3. Toxicological properties: To humans, to vegetation, and to terrestrial and aquatic animal life.

4. Sensory properties: Do the wastes produce odors; eye, nose or throat irritation; or unsightliness?

5. Thermal properties: Can they be burned? What is the heat of combustion? If ignited what combustion products result?

Under operating conditions, determine:

1. Rate of emission of the waste gases.

2. Variability of the rate.

3. Stack gas temperature, velocity and composition.

4. Do wastes result from batch or continuous operation?

5. Can the wastes be handled batch-wise, or must they be handled continuously?

Under expected dispersion, determine:

1. Calculation of average ground level concentration (one hour duration) downwind from the plant under a variety of weather conditions (check with Bosanquet and Pearson).

2. Calculation of peak concentrations (three minutes duration) downwind from a plant under a variety of weather conditions (Sutton).

3. Determination of the wind directions associated with:

a. Low wind speeds

b. Precipitation

c. Inversions

4. Measurement of wind gustiness types.

5. Estimation of terrain effects on wind direction, inversion persistence, etc.

Of the foregoing, most of the operating conditions and waste characteristics can be gotten from research or pilot plant data and published literature. The expected dispersion cannot be accurately judged without a fairly detailed knowledge of the site.

2. Study Conditions at Plant Site: Visit potential sites prior to the final selection of the site. But, remember, waste disposal is only one of many factors involved in site selection. Waste disposal could be the tail that wags the dog.

After the site has been selected, make . . .

1. An analysis of topographic maps and wind directions to locate areas

where high concentration would be most critical.

2. On-the-site measurements of wind variability.

3. On-the-site measurements of surface temperature and relative humidity.

4. A vegetation survey.

5. A preliminary waste disposal flowsheet.

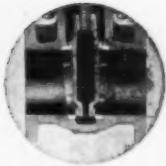
Be careful when analyzing the wind records. Average annual patterns may be completely misleading, especially if the plant is in a valley or partially surrounded by hills.

During the year the wind will blow from all directions, but dispersion will be slower in some directions than others. Consideration must be given to wind direction when precipitation or fog occur. Consideration must be given to the wind direction when the wind velocity is 0 to 3 mph.

Don't overlook the characteristics of the waste. For instance, if a powerful herbicidal dust is discharged, the average annual wind directions and speeds will apply to deposition calculations, providing the dust is fine (less than 5 m.) and closely sized. If the dust is coarse and extending over a wide size range, then the total deposition must be calculated from the sum of the depositions at low, intermediate and moderate wind speeds.

Knowledge of wind variability gives dispersion coefficients used for calculating ground level concentrations of stack discharges. Wind variability may be thought of as "horizontal gustiness" and is a measure of atmospheric turbulence. Specifically, it is the root-mean-square instantaneous deviation of wind direction from the average wind direction for a period of 15 min. or so. It is not the gross changeability of wind from, say, northerly direction to an easterly direction.

Next, the terrain. The effect of terrain is generally underestimated. Even small changes in contour can produce large drainage effects and small obstructions can act as cold air dams. Trees, hedgerows or buildings in line may do the same. (Continued)



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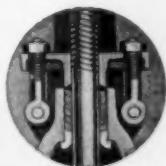
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QED, cont. . .

Air flow in valleys after sundown is frequently misunderstood. Supposedly, air drains into the bottom of a valley, and forms a cold lake at the bottom with progressively warmer air up the sides of the valley. This does not happen.

A cold lake forms at the bottom, but there is also a warm slope above it with a cold plateau above that.

To find stagnant air pockets on the site, keep records of surface humidity and temperature. A stagnant air pocket is an area of persistent high humidity, say over 95 percent, when precipitation is not occurring. After several weeks, two or three inexpensive instruments can reveal where air may stagnate, and how long it will persist. From these collected data, you can determine the probable duration of the stagnant conditions, especially if you combine wind analysis with them.

For a vegetation survey, hire an expert. He can make one in a few days. The survey should catalog the kinds of vegetation most susceptible to the particular wastes, and at the same time divulge existing damage. Cause of existing damage would be determined. Natural disease, insect pests, fungi and soil deficiencies may cause malformations that look like chemical injury.

3. Draw up a Disposal Flowsheet: A waste disposal flowsheet is as necessary to good design as a process flowsheet. On it, note sources, compositions, and characteristics; along with service information such as air, steam and electrical requirements.

After defining waste flow, a phase of close cooperation with design engineers will follow. Using collected data pick out methods to recover, collect and dispose of the wastes.

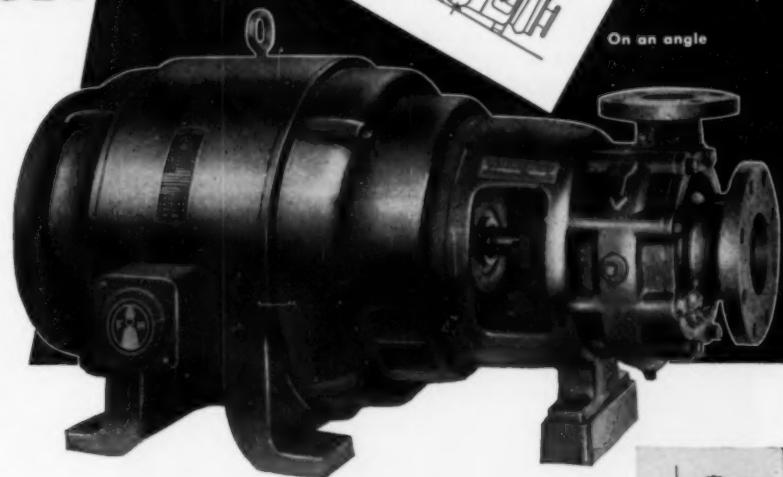
4. Calculate Capacities and Sizes: Starting with the flow sheet, determine which discharges are most critical. Picking sulphur dioxide gas as an example, you may quickly find that the sensory threshold is in the order of 2-3 ppm. Further, concentrations exceeding 0.5 ppm. will damage certain kinds of plants in so many hours.

Now, the limits are set. A quick check on the graph of the Sutton Equations (for maximum ground-level concentration and distance from the stack) will show that you can only discharge 10 cu. ft. per min. of sulphur dioxide from a 100 ft. stack, if you want to keep the ground level concentration for 2-5 min. below 2-3 ppm. However, this is effective, not constructed stack height.

In calculating the effective stack height,* consider the heat and velocity

* Also see articles, "Stacks for Pollution Control," in *Chemical Engineering*, Feb., March and April, 1952.

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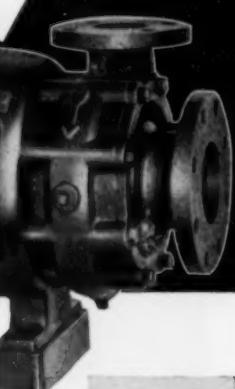
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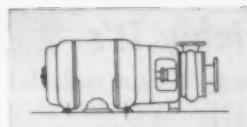
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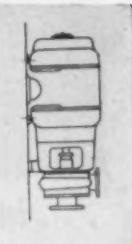
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effects of the stack gases. Both Bosanquet and Sutton present methods to do this. A word of caution—These methods have not been too well checked by independent sources; so use them conservatively. By comparing photographs of stack flow patterns with theoretical plume rises, you can check on the formula.

Before finally selecting the stack height, consider these factors: Height of nearby buildings; required ground level concentrations; what can be done to reduce the amount of waste effluent; can it be scrubbed and disposed as a liquid waste; can it be recovered?

Also remember, concentration varies rapidly with time when downwind from a stack. Concentrations will rise and fall as first one eddy and then another moves past an observing point.

Weather may affect concentration. For instance, Thornton and Setterstrom report that 16 ppm. of chlorine gas will damage 50 percent of tomato leaf area in 1-2 min. during clear weather, but it takes 60 min. to do the same in cloudy weather.

5. Cut Pollution During Start-Up: Don't neglect pollution abatement equipment during start-up stages. Also—although pollution may be high during start-up—avoid excessive pollution. You may create the impression that pollution from the plant will always be excessive. Avoid high pollution by determining critical conditions from prior analyses.

High pollution during start-up may come from rates and flows higher than those characteristic of balanced operation. Or it may be caused by bypassing. It may be desirable to bypass dust collectors and the like in order to simplify start-up procedures.

6. Run a Survey When Operation Begins: To confirm design or disclose additional work, a complex survey may be run. But usually, a few spot checks under critical weather conditions will do the trick.

However, any survey should include a check of actual against flowsheet conditions; measurements, direct or indirect, of the efficiency of the major equipment pieces installed for waste collection; stack samples; and observations downwind from the plant.

For dust surveys—a Greenberg-Smith impinger, connected to a windshield wiper, can operate from the manifold vacuum of a passenger car or pick-up truck. You can take a gas sample this way too.

If fume is extremely fine and in low concentration, use a venturi sampler, or electrostatic or thermal precipitator. The venturi can sample a large volume of air and concentrate the materials

collected in a small liquid volume. However, it must be carefully calibrated for the material collected.

Take samples during both turbulent and inversion conditions in the atmosphere. Contrary to wide-spread opinion, inversions are not unusual; they occur normally in almost all the U. S., but are more frequent in the fall. Take samples at the time of inversion break-up; high concentrations can be expected. However, this break-up will last only 15 min. to an hour, which makes it difficult to get samples.

Keep the material in mind. If the problem is long-term, as in corrosion, samples over a period of 24 hr. at a point will suffice. If short-term, as in most odor problems, then the samples should cover only a few minutes and should be repeated one after another.

To carry out the survey work, one of several plans may be selected. The best method will depend on the organization and personnel available to each company. Here are three common practices:

1. Designing engineers get the job. Disadvantage: design and plant engineers cannot specialize in everything, perhaps least of all waste disposal.

2. Call on a central waste laboratory or development section. Advantage: such an organization can test new methods and apply them to new or old problems. Disadvantage: removes responsibility for control of wastes from the plant.

3. Hire a group of specialists or consultants. This is easier said than done because qualified personnel are hard to find these days. Advantages: special knowledge can be brought to bear on the problems; experience from other work, both inside and outside the company, can be had with a minimum effort. Final responsibility remains with designers and operating engineers. This is as it should be in any line and staff organization.

After operation has begun, continue to watch waste disposal. If the plant is large, management could appoint a waste supervisor, who would act as a waste consultant for the plant. He would coordinate the technical, engineering and development work on the plant, conduct a plant educational program, organize pollution abatement work and act as liaison with control agencies and with the public.

REFERENCES

1. Read, G. M., "Six Major Factors in Site Selection," du Pont Educators' Conference, Paris, du Pont de Nemours & Co., June 19, 1951.
2. Lowry, P. H., *Compendium of Meteorology*, Waverly Press, Baltimore, p. 1151 (1951).
3. Gelzer, Rudolf, *The Climate Near the Ground*, pp. 195-214.
4. Dutton, J. H., Carey, F. W., Holton, R. M., "Dust Deposition from Chimney Stacks," *The Institution of Mechanical Engineers*, London (July 1948).
5. Sutton, O. G., "The Dispersion of Hot

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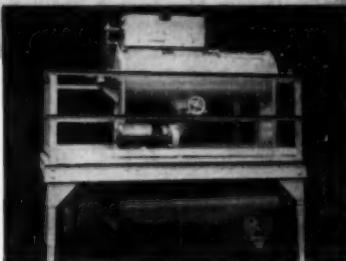


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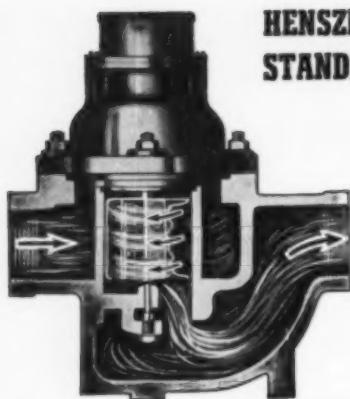
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Gases in the Atmosphere," J. Meteorology, 7, No. 307, (October 1950).
6. Thomas, N. C. and Setterstrom C. Toxicity of Ammonia Chlorine, Hydrogen Cyanide, Hydrogen Sulphide, and Sulphur Dioxide Gases.

7. Gosline, C. A., "Weather Engineering," *Colliers Encyclopedia*, New York, P. F. Colliers & Sons, 1950 Ed.

8. Gosline, C. A., "Dispersion from Short Stacks," *Chem. Eng. Progress*, (April 1952).

9. Gosline, C. A., "Stack Disposal of Chemical Waste," *Archives of Ind. Hyg. & Occup. Med.* 2, No. 6, pp. 621-630.

10. Gosline, C. A., "Air Pollution Abatement in Chemical Plants," *Am. Ind. Hyg. Assoc. Quart.*, 11, No. 1, pp. 20-29.

RESEARCH

... Russian Science

What is the status of Russian science today?

"The state of science and situation of scientists in Russia is one of the most contradictory aspects of the Soviet picture. It is impossible to describe it without admitting that things exist side by side that seem mutually exclusive," wrote Eugene Rabinowitch in the March issue of the *Bulletin of the Atomic Scientists*.

"Outstanding advances have been made in pure mathematics (Kholtomogorov, Vinogradov, Gelfand), and in several other fields of basic research; for example, the kinetics of chemical reactions (Semenov), colloidal chemistry (Frumkin), and ferroelectricity (Joffe) . . .

"Since the end of the Civil War, the most brilliant and independent minds among the younger generation in the Soviet Union have been attracted to science. Not only was the career of a scientist economically more attractive than almost every other career in the Soviet Union, but—what was even more important—science was the only field in which a man could enjoy intellectual freedom, choose his own subject of inquiry, think for himself, and communicate with those of similar interests all over the world . . .

"Undoubtedly, intellectual freedom provides the most favorable atmosphere for the advancement of science, but some of the greatest scientific discoveries in history have been made, and some of the most revolutionary ideas conceived, under absolute regimes lending secular power to the defense of anti-scientific church dogmas.

"The restrictions on freedom of science will not cause the brighter minds in the Soviet Union to choose other fields where pressure is less stifling—for the simple reason that no such fields exist . . .

"It is wrong to think of contemporary Soviet science as being largely paralyzed by the ideological dictator-

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QED, cont. . .

ship of ignorant politicians. Some branches may be stunted, but it is still a vigorous, growing tree . . .

"It seems that after years of this kind of schizophrenic life, many Russians have acquired a sort of immunity to it. . . . Praising Stalin as the greatest scientist of our era, or denouncing Pauling's theory of chemical valence as 'bourgeois pseudo-science' is, for them, merely a matter of mechanically performed obeisance."

"One understands that, not being able to utter a word of criticism of their own government . . . they find a measure of satisfaction in attacking the acts of British and American authorities that indicate similar isolationist trend. They feel—and rightly—that any Western 'reprisals' to Soviet restrictions of international communications are only likely to make the Soviet attitude still more intransigent."

HEAT TRANSFER

... Atomic Power

How long away is commercial atomic power?

Theoretically, atomic power plants should be just around the corner. One pound of uranium is the equivalent of 1,500 tons of coal. And at a cost of \$45 a pound, the ratio comes to 3 cents a ton—cheap fuel in any language.

But can industry look to 1960 or 1970 for actual atomic power plants. It cannot, according to an editorial last month in *Power*.

"Assuming that the atomic plant will cut fuel cost 4 mills per kWh., how much more can we afford to invest in the plant, other things being equal? At a 15 percent fixed-charge rate the 4 mills saving would justify an additional investment of \$230 per kw. for 100 percent load factor, or \$115 for 50 percent load factor. For the years to come, in our opinion, the extra cost of the atomic plant will be much more than \$230.

"If this estimate is correct, truly competitive atomic power on a large scale is decades away. Meanwhile experimental and subsidized installations on a limited scale may be just around the corner."

PULP PROCESSES

... Win for Soda

In this test, the soda process proved to be a better all-around worker than the mono-sulphite process.

Last year the Ceylon Government had the Forest Research Institute, Dehra Dun, compare the two proc-

esses in pulping illuk grass (*Imperata arundinacea*). Because of its better economy, the caustic soda process won out, according to the recently received Indian Forest Bulletin, No. 145. The cost of pulping the grass by the monosulphite process is 38 percent more than the soda process.

Of the two soda methods used—the overhead and the fractional processes—the fractional digestion worked out better and was cheaper. In this method, cooking liquor used in the first stage of digestion is the brown or "lignin" liquor collected from the second stage of digestion after completion of the cooking operation.

The pre-digestion is carried out at a low temperature and pressure with a cooking liquor of low concentration. In the second stage of digestion fresh liquor, composed of caustic soda, is used and the digestion is carried out at a high temperature and pressure. The concentration of the cooking liquor employed is also higher.

In the mono-sulphite or neutral sulphite process the cooking liquor is a solution of sodium sulphite containing a small amount of sodium carbonate. The process, successful for cereal straw pulping, is not employed commercially, as far as the Institute knows, for the reduction of grasses to pulp. However, the Indian government will continue development work on the process.

SYNTHETIC FIBERS

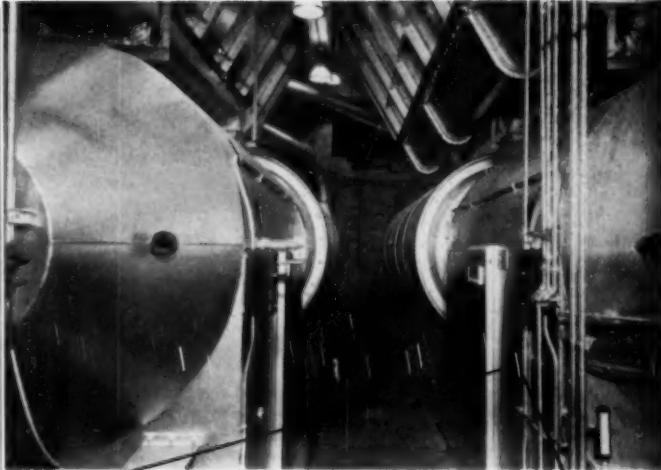
... All Is Not Gravy

World fiber sales in 1952 will probably top \$14 billion. With the textile market reaching mammoth size, prospective markets for synthetic fibers loom big and hopeful. Manufacturers of synthetics within a short time, it would seem, may soon take their bows.

Then again they may not. The bold venture into large-scale production of staple fiber could turn into a reckless, over-ambitious maneuver. At the recent meeting of the American Chemical Society at Buffalo, Carl A. Setterstrom of Carbide and Carbon Chemicals Co., New York, told members in opening an all-day symposium on new synthetic fibers that the industrial roof could fall in.

"Large-scale production of a new fiber is necessary to establish feasibility of the process, manufacturing cost, quality of product, and salability of the fiber. Pilot plant operations aren't extensive enough to predict the long-time efficiencies that make or break a fiber process. . . ."

"Sales development with pilot-plant poundages can be fatally slow or dangerously misleading. Actual consumer



Improve the quality of your output

Efficiently process
chemical and
drug residues,
sludges, sages,
leafy plants, etc.

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Drying

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Cyclo-Matic Drying gives highest quality output—that's relatively cool, due to rapid moisture evaporation, short retention time in drum. Preserves vitamins and nutrients. Accurately controls outlet temperature and moisture content. No boiler is required—heat exchanger losses are eliminated.

Ardrier Dryers cost you less to buy, install, operate, maintain. Capacities, 2,000—12,000 lbs. of water evaporated per hour.

See why Ardrier's exclusive 3-pass drum and showering flight design help you dry at lowest cost per ton. Send coupon for bulletins.

Ardrier Dryers are manufactured by The Heil Co.

Arnold Dryers
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Send me *Ardrier Dryer* bulletins.

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Pipe Cost - \$1,360
Plus Installation

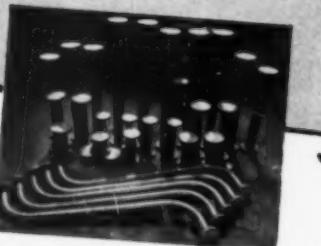
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Some of the Ways
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Mode furnishes rolls for printing textiles, developed non-toxic white rubber linings for food processing equipment, constructed special rolls for the new non-contact printing process, devised static absorbing rolls, and provided many other specials for troubled production executives.

Send for This Report

Details a case history on rubber lined pipe that applies to corrosion protection in any field. You will find it a thought-provoking text that may reveal ways you can use the services of our RUBBER ENGINEERS.



Amazing, yes—and 3½ years use has demonstrated that this saving is no temporary affair.

Many case histories have proven the merit of the La Favorite method of lining and/or covering pipe, valves, tanks and special equipment with exclusive La Favorite rubber compounds.

They have confirmed the value of this method of protection against corrosion and other destructive forces.

They show that it has SAVED countless thousands of dollars for users—and that is what counts!!!

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ILLINOIS ELECTRIC PORCELAIN CO.
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QED, cont. . .

acceptance on a fairly broad scale is necessary to temper laboratory findings, market surveys, and textile industry opinion.

"Large-scale production, however, requires the commitment of substantial capital and manpower to an unproved product. There are several important chemical companies which have invested or which plan to invest more than \$40 million each in staple fibers whose chemical structures are still subject to change, final properties unknown, methods of production not yet firmly established, costs uncertain, processing characteristics and dye affinities variable and markets only partially explored."

"The bold venture of the chemical industry into large-scale production of staple fibers may be the most dramatic success or the most costly failure in commercial chemical history."

PUBLIC RELATIONS

... Petroleum Pitch

Remember some 40 years ago when Henry Ford warned—if we continued to build automobiles there wouldn't be enough gasoline to run them.

"You can relax, I assure you," said Vice President Dwight Benton of Standard Oil Co. speaking to car dealers at the recent Chicago Automobile show.

"Although it has been predicted for decades that the petroleum supply was coming to an end soon, we have never yet run short of supplying both military and civilian needs. We have actually increased our reserves tremendously."

"Right now we know we have enough crude oil in the ground to produce gasoline for many years. And even if that was the end of the crude oil and we couldn't find any more, we know how to make gasoline by other ways. It is too costly to use those methods at present, but the time may come when the processes can be made financially worth while. If so, we know that from coal alone we can produce enough gasoline to last a thousand years."

GRINDING

... Radioactive Ringers

How have radioactive tracers worked out in recent communication studies?

Not bad—according to A. M. Gaudin, H. R. Spedden and D. F. Kaufman of MIT whose paper was pre-



FOR MEASUREMENTS FROM -100 F TO -300 F, G.E.'S TYPE HP-13 ON-OFF CONTROLLER GIVES STABILITY, ACCURACY, AND CONTROL SENSITIVITY

G-E Resistance-thermometers have High Accuracy; Can Be Calibrated within 1/2 of 1% Full Scale

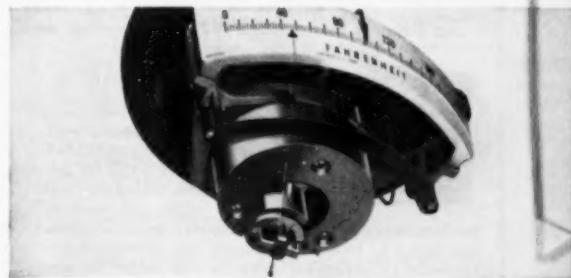
Temperatures from -100 F to -300 F can now be accurately indicated and controlled with General Electric's new line of resistance-thermometers. If you have an operation which demands close, accurate control, then there is a G-E resistance-thermometer tailored to your needs. Under certain conditions accurate indication is within $\frac{1}{2}$ of 1 per cent full scale.

CONTROL SENSITIVITY is built into G-E resistance-thermometers. A pointer motion not exceeding 0.1 per cent full scale length causes on-off operation in the presence of variations in voltage, ambient temperature, and frequency.

SPECIAL FEATURES include a mercury switch, rated 35 amperes for 120 volts a-c or 25 amperes for 240 volts a-c, available as an optional accessory for applications where heating loads exceed 10 amperes. When larger electrical capacity than that afforded by either control relay or mercury switch is required, a magnetic contactor can be supplied.

WIDESPREAD USE of G-E resistance-thermometers is a testimonial to their value. These close-control instruments can be used in refrigeration and food-processing industries, air-conditioning, medical and research laboratories, and in many applications where close control is a necessity.

MORE INFORMATION is available. Contact your nearest G-E representative, or write Section 602-230 for Bulletin GEC-835. *General Electric Company, Schenectady 5, N. Y.*



BASIC ELEMENT of G-E resistance-thermometers is crossed-coil moving element and 3½-pound alnico V magnet; designed to stand abuse.



TYPE HP-14 three-position resistance-thermometer with two-plug-in control units; shown with covers removed for easier maintenance.

GENERAL ELECTRIC

Maybe it all does look pretty much the same at first glance. But when a firm has been making wire mesh for 70 years man and boy, there's bound to be a little more to it than meets the eye—a little more know-how in engineering and weaving, a little more quality in the product, a little more service and satisfaction for the user.

JELLIFF WIRE MESH is woven in all ductile metals
JELLIFF WIRE MESH is woven in all commercial weaves
JELLIFF WIRE MESH is woven in widths up to 72 inches
JELLIFF WIRE MESH is economical. Every foot runs true to the specifications.



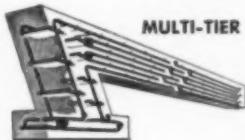
JELLIFF WIRE MESH is a quality product and has been for 70 years. You can depend on it.

Write today for full details about **JELLIFF WIRE MESH**, **JELLIFF WIRE MESH PRODUCTS**, and **JELLIFF'S CONSULTATION SERVICE** on wire-mesh engineering. Address Department 15.



CONTINUOUS PRODUCTION EQUIPMENT

for Bakery, Confectionery, Food, Chemical and Allied Industries



be invaluable in helping to convert from batch methods to continuous processing or to further simplify and streamline your present production processes. The Multi-Tier is the real answer to compact production and space-saving economy.

COOLING TUNNEL

As an alternate to the Multi-Tier where shorter production periods are required, the Greer Cooling Tunnel offers the most efficient answer where controlled temperatures and air circulation are a factor. Thirty years of developing and building such equipment makes these units available in widths ranging from 16" to 52" and lengths variable by 8'. The special sectional steel belt offers a feature which provides the most efficient cooling obtainable.



GREER **J. W. GREER COMPANY**
119 WINDSOR STREET, CAMBRIDGE 39, MASS.

WIRE MESH

QED, cont. . .

sented before the recent national meeting of the AIME. Radioactive tracers permit a personalized study. For the first time, investigations may go beyond the usual statistical limitations of size distribution research.

"Radioactive marking as a crushing research tool is both simple and effective. . . . The method seems to offer great promise in dealing with problems involving circulating loads where there is really no suitable commonplace technique now available."

How it's done: Make a screen analysis of a batch of crushed or ground mineral (say albite containing sodium). Then select some fraction such as the 28 to 35-mesh size. Bombard this fraction with a cyclotron making the sodium radioactive. Then weigh this fraction. Determine the intensity of the radioactivity with a Geiger counter, and relate the radioactivity to this weight.

Next mix the 28 to 35-mesh fraction with the other sizes, grind it in a ball mill for 2 min., make a screen analysis. Then weigh each fraction. Geiger them, and you will know how much of the 28 to 35-mesh material was reduced to each of the smaller screen sizes as a result of the 2 min. grind.

POWER

. . . Count on Coal

TVA is turning to coal.

Ninety percent of the new homes being built in Chattanooga, Nashville and Knoxville are heated entirely by electricity. To provide the power to heat these homes, and to supply industry in the area, the TVA has taken up coal. Eventually, the Bituminous Coal Institute reports, more than half the power produced by the TVA will be coal-generated.

"Coal is the one source of energy abundant enough to meet all the needs of the future. Of all of America's recoverable fuel reserves, 92 percent is coal."

RADIOLOGY

. . . Invisible Barriers

In nucleonic work, besides providing protective ventilation for normal processes going on in hoods and equipment, design engineers must consider the effects of explosions, fires, spills and other personnel accidents.

This is the opinion of Staff Engineer W. W. McIntosh of General Electric Co., Richland, Wash.

SYNTHETIC AGE

"At the beginning of the scientific period, man was still going humbly and submissively to the rock or the plant, or the sheep or the silkworm, and taking what was given him as the directive and limiting conditions of his building and weaving. Now he makes his pastes and pulps in whatever texture or fiber he needs."

H. G. WELLS

"An accident might make a room, or possibly a whole building unsafe . . . consequently, all practicable measures must be provided in the design for limiting the spread of radioactive contamination."

Speaking at the spring meeting of the ASME in Seattle, McIntosh told how nucleonic buildings are now being designed for controlled air flow.

Some designers provide for different air pressures between areas. These areas are usually designated as zones, the uncontaminated zones called "cold" and the areas of greater risk called "hot."

Cold and hot zones are completely separated structurally. Access between zones is through air locks. Air flows to areas of least risk and then passes out through equipment and hoods in the areas of highest risk.

"The air locks are not ventilated, but on opening the door toward the hot side air will leave the air lock toward the zone of lower pressure. When the air lock door to the cold side is opened, air will flow from the higher pressure area into the air lock; thus, air movement is in the proper direction. Air lock doors may be interlocked to prevent simultaneous opening that might upset the ventilation balance.

"The provision of one source of supply air and one exhaust system for all zones avoids the danger of zone pressure differential violations that might be caused by failure of one of several separate supply or exhaust systems.

"This alone is a determining factor in over-all design; since reversal of air flow, which might be caused by the failure of a single fan, cannot be tolerated in some buildings for even a few seconds."

HEAT TRANSFER

... Boiling Refrigeration

One way to cool a liquid is to pass it through tubes immersed in a boiling refrigerant. Tests have been run in such systems using horizontal finned tubes. Little has been done using plain tubes. And until D. B. Robinson and J. E. Myers made their recent

**25 YEARS OF LEADERSHIP
IN FASTENINGS OF STAINLESS STEEL**



To YOU, the 25th Anniversary of Anti-Corrosive is an assurance that when your requirements call for fastenings of stainless steel, you can depend on Anti-Corrosive to serve you best! Anti-Corrosive is the oldest, largest and best-known firm dealing exclusively in stainless steel fastenings . . . an enviable position in a fast-growing industry . . . your guarantee of product excellence!

Still Plenty of Fastenings IN STOCK

If you need quick delivery of stainless steel fastenings, check Anti-Corrosive first! Although most of our production requires D. O. Ratings, there is still a wide variety of stock items in our bins which may fit your needs . . . or, a suitable alternate ready for immediate delivery may be suggested!

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**"LIQUIDS WORTH STORING
ARE WORTH
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with a

LIQUIDOMETER

*Tank
Gauge*

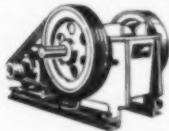
- FOR GAUGING LIQUIDS
OF ALL KINDS
- 100% AUTOMATIC
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UNDERWRITERS'
LABORATORIES

WRITE FOR COMPLETE DETAILS

THE LIQUIDOMETER CORP.
36-29 SKILLMAN AVE., LONG ISLAND CITY, N.Y.

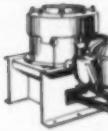
Laboratory Crushers & Pulverizers

LABORATORY JAW CRUSHER



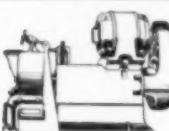
Double acting jaw delivers two blows per revolution, speeds crushing. Forward and downward motion increases capacity over conventional stroke, particularly on moist materials. Hand wheel replaces usual wrench or shims for jaw opening adjustment. Discharge openings: $\frac{1}{4}$ " to $1\frac{1}{2}$ " available. Welded steel construction. Reversible jaw plates.

GY-ROLL REDUCTION CRUSHER



Reduces $\frac{1}{4}$ " feed to as fine as 10 mesh in a single pass. Very high capacity and low power consumption; replaces bulky, unhandy equipment such as rolls and coffee mill. Sizes available, 6" and 10".

LABORATORY PULVERIZER



The Masco-McCool is a disc-type grinder designed for pulverizing to fine meshes in one operation. Planetary disc movement assures long grinding surface life. No gears—reduces power; 100% anti-friction grease lubricated bearings; grinds more samples per hour at lower cost.

New free CATALOG gives complete information on Masco laboratory crushers and pulverizers; Marcy grinding mills for laboratory, pilot plant and commercial grinding; Masco-Grisby rubber pinch valves.

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Offices in Salt Lake City, El Paso, 1775 Broadway, N.Y.C.

QED, cont. . .

CONTINUOUS DILUTION

"The research director may be wrong half the time; a committee of any kind will be wrong most of the time; and a committee of vice-presidents would probably be wrong all the time."

C. E. KENNETH MEES
Vice President
Eastman Kodak Co.

studies on boiling coefficients, no data were available for comparing the two types of tubes.

In January's *Refrigerating Engineering*, Myers published some of their experimental results:

"In all cases the boiling coefficients per square foot of outside surface were greater for the finned tubes than for the plain tubes but at higher temperature differences they appear [when plotted] to converge or cross.

"In computing the resistance of the tubes, it is necessary to consider fin efficiencies. The tubes were made of copper, which has a high thermal conductivity. Since the fins were very short, it was found that the efficiencies were always 96 percent or more and so they were used as 100 percent in these computations.

"In general, fouling on the inside of the tubes would reduce the advantage shown for the finned tubes over the plain tubes while fouling on the outside, if it should occur, would increase the benefits obtained from the finned tubes, percentagewise.

"It may be concluded that finned tubes have their maximum advantage at low temperature differences."

MARKETS

. . . Insecticide Forecast

With the exception of pyrethrum, most ingredients used in the manufacture of insecticides are in good supply.

Here is the outlook for the rest of the year for the supplies of the principal insecticide ingredients, according to the National Production Authority:

Alethrin—No shortage has developed so far. Military requirements for use in aerosol bombs have not been sufficient to limit availability for civilian use. Present production by the sole producer, Union Carbide, will be augmented by another plant that will begin operation this year and a third in 1953. Total production will be about 500,000 lb. a year.

DDT—The estimated 1952 supply of 130 million pounds will balance requirements. Department of Agricul-

TWO TERRY TURBINES IN RECORD NON-STOP RUN AT CITIES SERVICE

After 26 Months of Continuous Operation, Cost of
Replacement Parts Only \$78.00 for Each Turbine

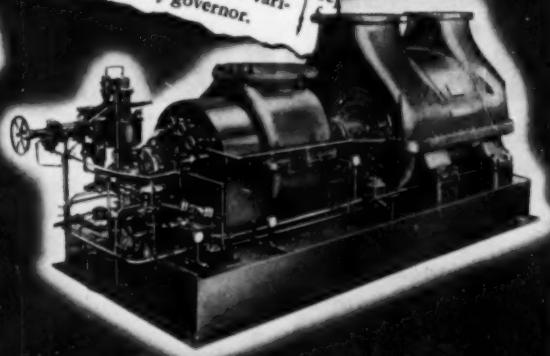
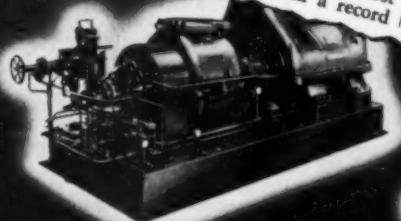
Two Terry turbines recently completed a record non-stop run at the East Chicago refinery of Cities Service Oil Company. Specifically designed for driving air blowers on fluid catalytic cracking, they ran continuously from initial start up, day and night, for two years and two months. Throughout the entire run neither turbine suffered any noticeable reduction in efficiency.

On inspection, after shutdown, it was found that the only parts showing signs of wear were the shaft packing rings. These were replaced at a total cost of \$78.00 for each turbine.

While this extremely low cost for repairs, after such a record

run, could not have been anticipated, Cities Service had good reason to expect outstanding performance from Terry turbines. A four-year record of 216 Terry turbines at the same company refinery of this amazingly low maintenance costs. During this period, the yearly cost of replacement parts averaged only 1.4% of the initial investment.

The two turbines at East Chicago are rated 2450 horsepower at 5030 rpm. Each is equipped with a trip throttle valve, forced feed lubrication, and regulator for process control applied to a variable speed oil relay governor.



For more information about Terry multistage turbines, send for a copy of Bulletin S-146. No cost or obligation.

TERRY

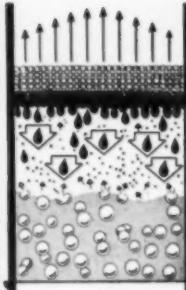
THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

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Look into **METEX MIST ELIMINATORS**

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boost production and cut costs



Removal of liquids entrained in gases is simple . . . economical . . . effective —when you use Metex Mist Eliminators! As the mixture passes through the Mist Eliminator, the entrained liquid is wiped out and retained by the extensive KNITTED wire area—until it coalesces into drops that are large

enough to fall back through the rising flow. The gas passes on—freed from entrainment.

Efficiencies 95% or better • Little if any pressure drop • Can be installed in existing equipment • Made of practically any metal • No moving parts

Worth looking into, isn't it? Ask for your free copy of "Metex Mist Eliminators", an 8-page brochure that's packed with facts. Or write us about your specific entrainment problem.

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INDEPENDENT FABRICATORS & ERECTORS

QED, cont. . .

ture will take about 85 million pounds; military, 5 million; and export, about 40 million. Production of DDT should rise from 105 million pounds in 1951 to 155 million pounds in 1955.

Pyrethrum—Although the present stocks are low, 1952 imports probably will equal imports received in 1951. A report from Kenya (Africa) states that 1951 production was 20 percent above 1950. Increase in Brazilian production probably will add little to amounts available for U. S. use. Imports for the first 11 months of 1951 totalled 6.1 million pounds compared with 8.3 million pounds for 1950.

Rotenone—The supply, reports states, is high. Imports in 1952 will depend on demand. Imports for the first 11 months of 1951 totalled 5.6 million pounds compared with 9.8 million pounds for 1950.

Chlordane—Supplies this year probably will meet demand.

Lindane—No shortage reported.

—End

MEMO FROM THE EDITOR

Continued from page 145

After a stint as production instructor at Du Pont's Martinsville plant in Virginia, Morgan became a foreman at the same unit. Then the company shifted him to its Wabash River Ordnance Works to turn out RDX and high explosives for our fighting men.

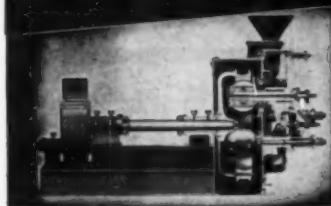
Then in 1944 came his transfer to Hanford Engineering Works up on the Columbia River in Washington. There, for two years, Morgan was a supervisor in the famous plutonium chemical separation plant. He was there when I visited Hanford on V-J Day.

In 1946 Morgan joined American Cyanamid, went down to Piney River, Va., as chemical engineer in the titanium dioxide plant. He joined CE's New York staff in the summer of 1949.

Besides being active in the chemical corrosion field, Morgan's more than knee-deep in local AIChE affairs. Right now, for instance, he's secretary of the New York section as well as co-chairman of that section's annual symposium (Cecil Chilton of our staff is the other co-chairman).

In spite of these professional affairs, though, Morgan somehow manages to take part in community activities in Greenwich, Conn., where he now lives with his wife "Beezv" and their three-year old daughter, Elizabeth.

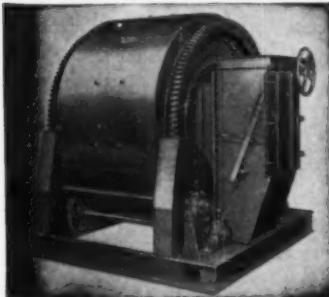
Step-up Production Lower Preparation Costs with **STURTEVANT EQUIPMENT**



RING ROLL MILL — for medium and fine reduction of hard or soft materials (10 to 200 mesh). Open-door accessibility for easy cleaning. Available in many sizes and capacities.



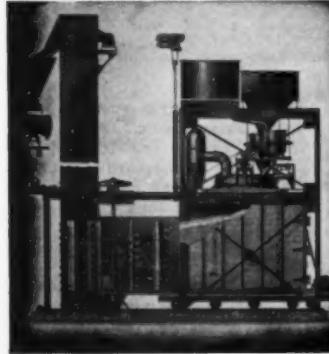
TAILINGS ROTARY PULVERIZER — increases output of fertilizer tailings . . . will not clog . . . leaves no daily accumulation of unground pellets. Capacities up to 25 tons per hour.



DRY BATCH MIXERS — 4-way mixing action mixes two or more ingredients into an inseparable, homogeneous mass. Open door accessibility makes cleaning easy. Capacities $\frac{1}{2}$ ton to 2 tons.



MOTO-VIBRO SCREENS — screen everything screenable. Open and closed models with or without feeders. Many types and sizes . . . screens from $\frac{1}{2}$ to 60 mesh.



DBN AND EXCAVATOR — speeds processing of superphosphates. Easily operated by two men . . . produces 16 to 40 tons per batch and up to 480 tons per day of superior fertilizer free from impurities.



AIR SEPARATOR — for finest separation of materials. Capacities from $\frac{1}{2}$ ton to 50 tons per hour in fineness of 40 to 325 mesh and finer. Increases production of fines, cuts power consumption costs.

Sturtevant Processing Equipment . . . Grinders, mixers, separators, screens, etc. . . . can help you reduce today's high manufacturing costs by increasing both machine and operator output, lowering production costs, assuring high quality products.

Records in all types of industries — chemical, plastics, ceramics, cement, food, construction — prove that this equipment works dependably day in, day out with little, if any, maintenance.

Used individually or linked together in proper sequence, they do the job faster and easier than other types . . . handle a larger variety of work.

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TRANSISTORS

(Continued from p. 156)

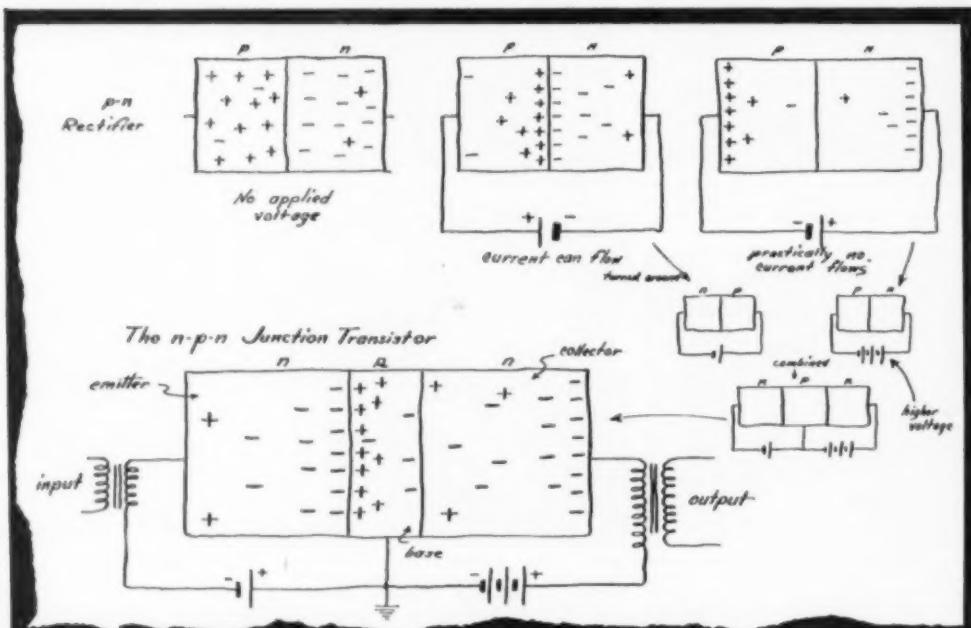
but try and get one. Production is just getting started, and the military gets most of them. Some are going into telephone service. Bell's manufacturing subsidiary, Western Electric, is just getting into volume production of the point-contact type. Western Electric has also licensed Radio Receptor Co. of Brooklyn, N. Y., to make transistors. General Electric is

producing germanium rectifiers and point-contact transistors. Raytheon had one model selling for \$18, but withdrew it for a new model just becoming available. Sylvania makes germanium diodes, is still in the engineering stage with transistors, as is RCA. Bell, GE and the others are turning out a few junction transistors for use in development work, but output isn't significant yet.

Daily output of point-contact transistors by the industry is estimated at 200 to 300 by the head of solid state physics research for one of the

companies. Another source puts current production of transistors at 20,000 a month and growing. In four or five years, predicts one electronics industry sales executive, 5 to 10 million a year will be turned out.

Not much has been done yet on machinery for producing transistors in volume. They're now put together manually under microscopes. But when mechanical methods are devised, thinks J. A. Morton, a Bell development engineer charged with getting them into production, transistors may control the machines that make them.



ENGINEER'S TABLECLOTH SKETCH shows how electrons and holes behave in a *p-n* junction rectifier and how a transistor can be considered as two *p-n* junctions in a single germanium crystal. This concept helps clarify the theory of transistors.

How Transistors Work

Germanium has four valence electrons. Like the diamond, it crystallizes in a cubic lattice. Each germanium atom is held to its four neighbors by covalent bonds of paired electrons.

ELECTRONS AND HOLES

Heat or light energy can knock electrons out of these covalent bonds. When an electron is thus ejected, it is free to wander through the crystal lattice, carrying its negative charge.

The position vacated by the electron is called a "hole," and, since it is the absence of an electron, acts like a positive charge. Every time an electron moves into one hole, a new hole is left. When the electrons move through the crystal, they produce the effect of holes moving in the opposite direction, carrying positive charges.

At normal temperature, electrons and holes are being liberated and are recombining continuously. This is

what makes pure germanium an intrinsic semiconductor.

If an electric field is applied to an intrinsic semiconductor, the electrons move toward the positive terminal and the holes toward the negative terminal.

ADDITION OF IMPURITIES

Adding certain impurity atoms to the germanium crystal can greatly change its conductivity. If, for example, an atom of phosphorus, with five outer electrons, replaces a germanium atom in the crystal, the extra valence electron in the phosphorus is free to move through the lattice,

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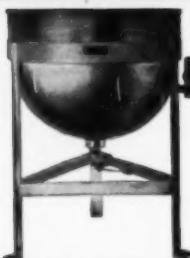
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TRANSISTORS, cont. . .

carrying its negative charge. Phosphorus, like arsenic and antimony, is a donor impurity because it gives an excess electron to the crystal.

If the impurity is an element such as boron, with only three electrons, a hole is left in the covalent bond. This positive hole is free to wander in the crystal. Boron, together with aluminum, gallium and indium, is an acceptor impurity since it picks up an electron from within the crystal, thus freeing a hole to migrate.

It takes but a few donor or acceptor atoms to produce big changes in conductivity (as little as one part in 10^9 of some impurities can be detected electrically). If conduction is by excess electrons from donor atoms, the germanium is n-type because the current is carried by negative charges. If due to holes, it is p-type since the carriers act like positive charges.

BASIC PRINCIPLES

Basic to a grasp of how a transistor amplifies is the idea that conduction through germanium can take place in two distinct ways at the same time: by a flow of excess electrons and by a flow of holes.

Two other things about semiconductors like germanium are important: (1) a stream of holes can be injected into an n-type semiconductor, and a stream of electrons into a p-type, by passing current into it; and (2) electrons travel much more slowly in a semiconductor than they do in a conductor, and holes travel even more slowly—about half as fast as electrons. When an electric field is applied to germanium, an electron has a mobility or drift velocity of 3,600 cm./sec. per volt/cm., compared with 1,700 for a hole.

HOW RECTIFIER WORKS

Consider now what happens in a p-n junction rectifier. This consists of a single crystal bar of germanium, with a p-zone next to an n-zone in the same continuous lattice structure. A rectifying barrier can be created at the junction of the two zones.

When no potential is applied, there are an excess of holes in the p-zone and an excess of electrons in the n-zone. Their number is a statistical function of temperature, some carriers being trapped by the impurity centers, while others are being excited into the lattice (see cut, p. 370).

If a voltage source is applied to the two ends of this p-n junction, with the positive terminal connected to the p-zone and the negative to the n-zone, holes in the p-zone and electrons in the n-zone flow toward the junction.

At the junction, some holes and

electrons meet and recombine. But many holes cross the junction into the *n*-zone, carrying current by their positive charges. Likewise, many electrons cross the junction from the *n*-zone, carrying negative current charges. The over-all effect is that of electrons flowing from the *n*-zone across the junction into the *p*-zone. The voltage source keeps this going. Resistance is low, and a high current flows. Increasing the voltage steps up the current flow.

When the polarity of the applied voltage is reversed, holes and electrons are pulled away from the junction and away from each other.

There are now few holes and electrons at the junction to meet and recombine. Any holes that do reach the junction are repelled by the electric field from crossing into the *n*-zone. Stray electrons near the junction are repelled in the same way from crossing to the *p*-zone. As a result, almost no current carriers travel across the barrier in either direction. Resistance is high, and little current flows. Increasing the voltage does not increase the current because higher voltage only pulls harder on the holes and electrons, keeping them apart. The junction acts as a good rectifier.

HOW JUNCTION TRANSISTOR WORKS

Transistors can be either *p-n-p* or *n-p-n* type. The *p-n-p* transistor operates mainly by diffusion of holes through *n*-germanium, and the *n-p-n* mostly by diffusion of electrons through *p*-germanium. Point-contact and junction transistors can be either *p-n-p* or *n-p-n*.

The *n-p-n* junction transistor consists of a single crystal bar of germanium, having a thin *p*-zone between two *n*-zones. Since the *n*-zones have donor impurities in the lattice, they contain excess electrons. The narrow *p*-zone, with acceptor impurities, contains an excess of holes. One of the *n*-zones is called the emitter, and the other the collector. The center *p*-zone is called the base (see cut, p. 370).

When a d.c. battery is connected by its positive terminal to the *p*-zone base and by its negative terminal to the *n*-emitter, current can flow across the junction between the emitter and the base, just as in the rectifier when it's carrying current.

Electrons from the emitter flow to the emitter junction, and holes from the base also flow to it. At the junction, some electrons and holes recombine. But the battery voltage sends excess electrons from the emitter across the low-resistance junction into the center base region.

Another d.c. battery, one with higher voltage, is connected by its positive terminal to the *n*-zone col-

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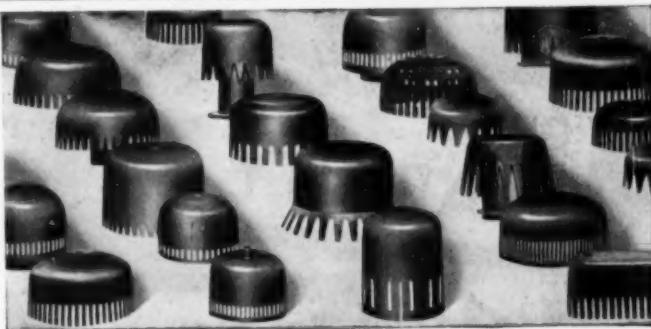
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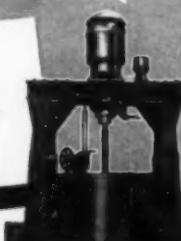


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TRANSISTORS, CONT'D. . .

lector and by its negative terminal to the p-base. This reverse voltage pulls holes in the base region away from the junction between the base and the collector. It likewise pulls electrons in the collector away from the junction. Thus it greatly impedes the flow of current across this collector junction, just as in the rectifier when its junction acts as a barrier. Increasing the reverse voltage across the collector junction will not increase the current in the collector circuit of the transistor.

But this same battery voltage across the collector junction does not repel excess electrons that have entered the base zone from the emitter. With enough of their own emitter voltage behind them, many electrons stream from the emitter, enter the base, cross the collector junction and travel to the collector terminal, where they add to the collector current.

Thus most of the current flow between emitter and collector in the n-p-n junction transistor is due to electrons from the n-emitter that diffuse through the thin p-zone base into the n-collector without recombining with holes in the base. The p-base is purposely kept thin to minimize recombination.

CURRENT AMPLIFICATION

Increasing the emitter current frees more electrons to flow through the base into the collector, where they add to the collector current. Conversely, decreasing the emitter current decreases the flow of electrons from emitter to collector, reducing collector current.

The current amplification, α , is the change of collector current for a change in emitter current at a constant collector voltage:

$$\alpha = (\Delta I_c / \Delta I_e)_{v_C}$$

The factor α depends on γ , the fraction of emitter current carried by electrons, on β , the fraction of electrons from the emitter that arrive at the collector, and on A , the fraction of electrons picked up at the collector:

$$\alpha = \gamma \times \beta \times A$$

If the emitter current were all electrons and none recombined with holes in the center p-zone, and all of them reached the collector, then γ , β and A would each be 1, and α would have a value of unity. In practice, values of 0.95 to 0.98 can be achieved, and there are ways of making A higher than 1 and thus getting greater α values.

POWER GAIN

Even when the current amplifica-



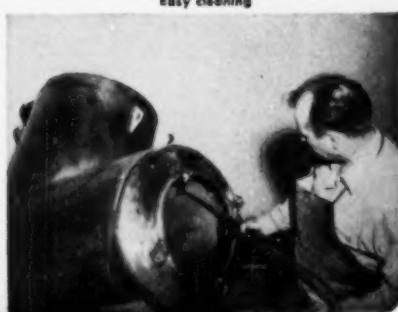
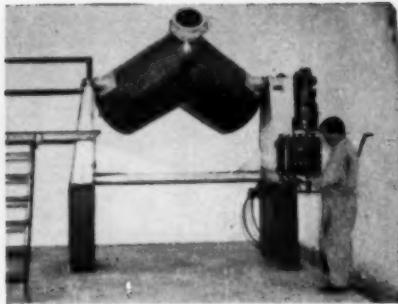
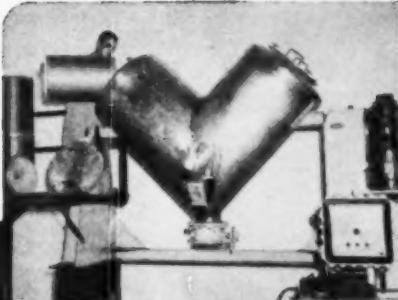
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CHEMICAL ENGINEERING—May 1952

375

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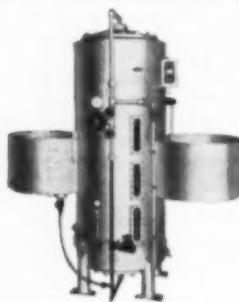
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TRANSISTORS, cont. . .

tion is less than unity, power gain can still result.

Since current flows almost unimpededly across the emitter junction, it takes but a small a.c. voltage, and thus a small power input, to send electrons streaming from emitter to collector, where they add to the current.

This increased current in the collector circuit, however, is greatly impeded in its flow across the collector junction, resulting in a large a.c. voltage and a high power output.

For low feedback, the power gain approximates $a^2 r_e / 4 r_c$, where r_e is the resistance of the collector junction and r_c that of the emitter junction. Junction transistors that amplify power 100,000 times have been made.

HOW POINT-CONTACT TRANSISTOR WORKS

In the point-contact transistor, two pointed probes or whiskers only 0.002 in. apart touch the top of a germanium block. These point contacts are the emitter and collector electrodes. The base electrode is a large-area low-resistance contact soldered to the bottom of the germanium block.

During manufacture, the contact areas where the emitter and collector points touch the germanium are "formed" by passing current pulses through them. This creates small areas of p-type germanium directly under the points. Since the body of the block is n-type, this point-contact transistor is a p-n-p unit.

Operation is similar to that of the n-p-n transistor. But the polarities of the battery voltages must be reversed. For instead of electrons, as in the n-p-n type, holes carry current from the emitter through the n-base to the collector in the p-n-p transistor.

CURRENT MULTIPLICATION

In the point-contact transistor, unlike the junction transistor, an actual current amplification occurs, and a values far higher than unity can be attained. Just why is not clear.

If all of the current from the emitter were holes and all of them reached the collector point and were picked up, this alone would account for an α value of 1. But in addition, holes pile up around the collector point, and the cluster of positive charges attracts electrons from the collector point. And, since holes travel only about half as fast as electrons, they tarry twice as long near the collector point—long enough to attract not one but two electrons from the collector point. However, these facts can only account for α values up to 3. And far higher values are obtained.

(Continued)

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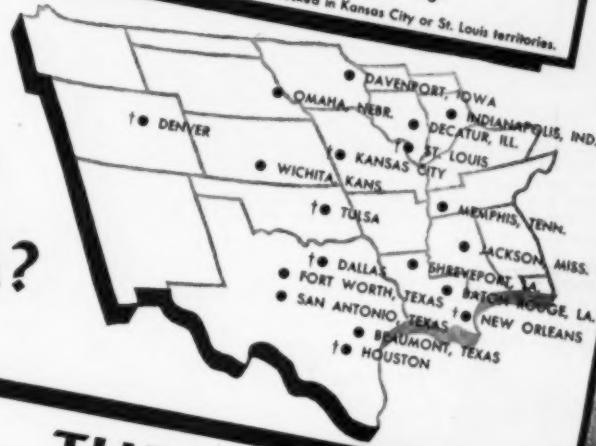
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TRANSISTORS, cont. . .

One way to account for high α values is the p-n hook theory of Dr. William Shockley of Bell Telephone Laboratories. According to this theory, an n-type region between the p-collector and the collector point provides an added p-n junction, and holes are trapped in the p-region near the collector point because of the "hook" in potential across this junction. Holes trapped near the collector point would form a large cluster of positive charges

and attract more electrons from the point. This could account for large possible values of α . Shockley reports values of 20 for collector contacts that seem to function by the hook mechanism, and even greater α values are possible.

Transistors, then, can amplify by two methods. One is due to the fact that the output impedance is much higher than the input impedance. The other is due to α , the current gain possible in point-contact transistors and the newer hook-collector units.

shows, almost 70 percent (11¢) of this increase is due to taxes alone.

Table III also brings out the fact that the petroleum companies, in pricing their benzene at about 45¢, are aiming for somewhere in the neighborhood of a 20 percent net return after taxes. They may work with payout times, etc., but the net result is the same. Interestingly enough a net return of 20-25 percent is just about what most large chemical company managements require for this type of operation, in other words production of an existing product where fluctuations in the business cycle might be a major factor in the profit picture. In the case of benzene, of course, this is serious because the bulk of the supply is byproduct material from coke ovens.

BENZENE COST (Continued from p. 157)

It also means that, due to the obvious imperfection of any such evaluation down to the third significant figure, a petroleum company must require a relatively high margin of profit to insure against relative cost changes in the feed and effluent of such a unit.

The second interesting fact is the effect of taxes. About five years ago it was said that benzene would start to flow from petroleum sources when the price of benzene reached 28-30¢ per gal. Today the figure being discussed, and at which contracts are probably being made, is 45¢. As Table III

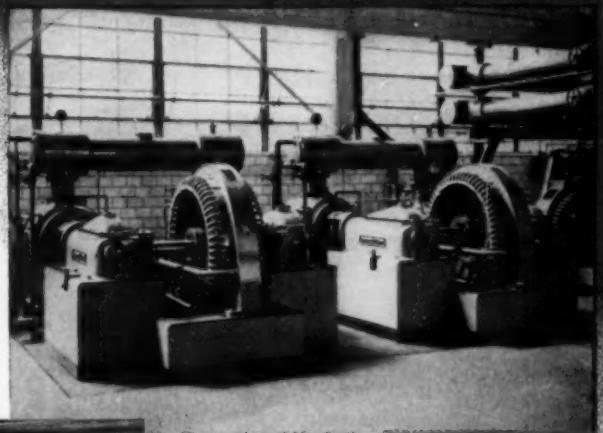
PROFITS Expressed as Return on Investment—Table III

(Current tax rates—45¢ price)

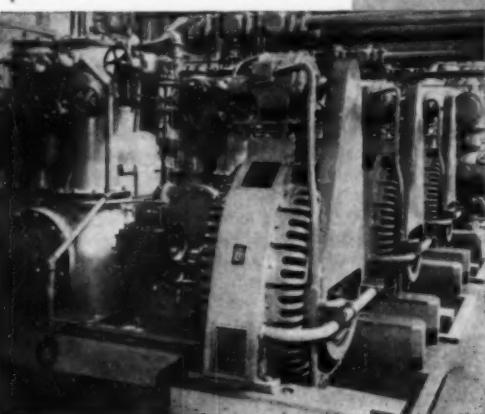
Investment			
Permanent investment			
Platformer.....	\$675,000		
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Total.....	<hr/>	<hr/>	\$1,010,000
Allocated investment			
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Steam.....	12,000		
Electric.....	13,000		
General facilities.....	61,000		
Total.....	<hr/>	<hr/>	101,000
Working capital			
Accounts receivable.....	157,000		
Inventories.....	80,000		
Cash.....	80,000		
Deferred charges.....	7,000		
Total.....	<hr/>	<hr/>	324,000
Total investment.....	<hr/>	<hr/>	\$1,435,000
Dollars per gallon per year.....	<hr/>	<hr/>	0.3420
Sales @ 45¢ per gallon.....	<hr/>	<hr/>	Dollars Per Gallon
Less cost of sales.....	<hr/>	<hr/>	Per Year
Gross profit.....	<hr/>	<hr/>	\$1,890,000
Less taxes @ 70%.....	<hr/>	<hr/>	0.450
Net profit.....	<hr/>	<hr/>	993,000
Return on investment.....	<hr/>	<hr/>	0.236
Return on sales.....	<hr/>	<hr/>	18.75%
Turnover.....	<hr/>	<hr/>	14.5%
Benzene Profits—Old Tax Rates—To yield 18.75% Net Return on Investment,	<hr/>	<hr/>	1.32
Net profit.....	<hr/>	<hr/>	269,000
Taxes @ 38%.....	<hr/>	<hr/>	165,000
Gross profit.....	<hr/>	<hr/>	434,000
Cost of sales.....	<hr/>	<hr/>	993,000
Sales price.....	<hr/>	<hr/>	1,427,000
			0.34

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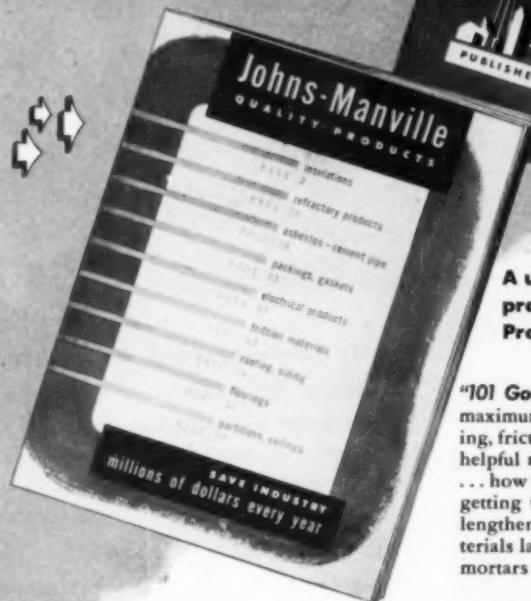
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Chemical Engineering is the production of X from A, economically and in commercial quantity and quality.

Unit tasks are the things that have to be done to accomplish this A to X objective.

Techniques are the means used to get these unit tasks (and sub-tasks) done most effectively.

Due later this month is a book that will probably excite some controversy.* By means of a wholly imaginary interview, let's put a few questions to the authors. We can, after studying and reading the book, pretend to answer for them.—ED.

QUESTION: Your book will soon be ready, won't it Dr. Lauer?

ANSWER: Yes. And that "your" is plural. Russell Heckman, who is assistant professor here in the department of chemical engineering at the University of Colorado, is co-author.

Q: How much will the book cost?
A: It will be \$6.

Q: What's it all about?

A: Chemical engineering techniques.

Q: And what do you and Prof. Heckman mean by techniques?

A: A technique is a way to get something done. To get 10,000,000 gal. of oil from Texas to New Jersey; to separate juice from sugar cane; to package a product.

Q: I see. And your book tells what techniques are available and a little bit about them.

A: We know that many chemical engineering students spend a large part of their college years without ever being aware that there is a systematic arrangement of the methods of chemical engineering. Therefore we want to point out the basic objectives of chemical engineering and present some of the techniques for reaching them.

Q: And what is your technique for getting this idea across?

A: The chemical engineer is concerned with making product X out of raw material A. To do so he has to complete a series of tasks. They are the so-called unit operations and unit processes. We call them unit tasks. In our book we tell what they are.

* CHEMICAL ENGINEERING TECHNIQUES.
By B. E. Lauer and R. S. Heckman. Reinhold Publishing Corp., New York. 496 pages. \$6.

Q: Why introduce this new concept?

A: There are many books relating to unit operations. We object to that concept because the student is apt to look on the operation as an end rather than a means to an end.

Q: How many unit tasks are there?

A: Six. Assembly of materials; preparation of materials for reaction; production and distribution of energy; conditions affecting the chemical reaction; separation and purification of materials; and further treatment of products for sale, shipment, storage or other use.

Obviously, these can be broken into sub-classifications. We call them unit sub-tasks.

Q: How does your book handle this breakdown?

A: There are 25 chapters in six sections. Each unit task is a section; each unit sub-task, a chapter.

Q: Tell us something about the first section—the first unit task.

A: Assembly of materials has three unit sub-tasks: interplant transportation, intraplant transportation, storage of materials. Interplant transportation, of course, takes in types and features of water, rail, truck and air transportation, pipelines and belt conveyors. We have also included a cost summary.

Intraplant transportation is the longest chapter in the book because here the student meets pumps, pipes, and valves for moving liquids. Here, too, are the techniques for moving solids and gases.

Q: I notice this division very often in your (that's plural) book.

A: It's the logical thing to do. You have also noticed, I suppose, that there are many outlines.

Q: Yes, and mighty good ones, too.

A: They will help the student get a proper perspective.

Q: Let's look at Section II. What do you regard as particularly noteworthy here?

A: Preparation of materials for reaction is the shortest section in the book. But that's not very noteworthy. I do think, however, that size reduction—which is the first sub-group here—has one feature which is often overlooked. At least under emphasized. I mean size reduction in liquids. At first this sounds slightly ridiculous. It isn't, because many processes require large liquid surface areas for a given unit of weight. Our discussion covers the two classes of nozzles and the two techniques for breaking a liquid into a spray.

Q: What's in Section III?

A: There are four chapters that cover the sources, conversion, storage, distribution and conservation of energy, and removal of heat from a material.

Q: And in Section IV?

A: A short but most valuable section. Here are the techniques for quantity measurements and proportioning; for measurement and control of pressure and temperature; for mixing. There is a good chapter on techniques for conducting reactions: gases with gases, solids with liquids, and so on.

Q: Don't you think the next section is best and most important?

A: Possibly. This section on separation is very important because reactions seldom yield single products. And mixtures of raw materials, products, byproducts and residues are not usually worth much.

We discuss solids, liquids and gases and their separation from other solids, liquids and gases. That makes nine sub-tasks.

Q: Why have nine separate chapters? Why not six? How does the chapter on separating solids from liquids differ from that on separating liquids from solids?

A: They are not the same. Liquids from solids means liquids from essentially solid masses—centrifuges, filters and dryers. Solids from liquids—evaporators, crystallizers, solvent extraction, precipitation, electrodeposition, spray dryers. (Continued on p. 382)

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Theoretical uses

Plots theoretical curves and results of theoretical calculations.

General uses

Plots insurance tables; stock market, statistical and financial records; production control data; results of engineering studies and analyses; management control data.

Plots results of continuous process operations for supervision and control purposes.

BOOKSHELF, cont. . .

You and your readers can recognize that separation of solids from gases uses techniques quite different from those used for getting gases from solids. Compare a Cottrell precipitator with a rotary kiln.

Q: Separating solids and liquids seems the most important. The subject takes about 40 percent of Section V.

A: Yes, and the section is 25 percent of the book's text.

Q: While we are talking numbers, how many pictures are there? I thought they were good, but felt that there should have been more. Particularly sketches that would help in getting ideas across.

A: I don't know how many pictures there are. I do know that we sent the publisher about 1,000 more than he could use. They had to be left out to keep the book's price down to a reasonable figure.

Q: Wise. Perry's Handbook will help the student if he wants working data or equipment details.

A: Yes. And we have prepared a special filmstrip for teachers. It has all the illustrations in the book plus the 1,000 that had to be left out.

Q: Let's have a little more of your thoughts regarding your book and its place alongside Perry's.

A: We emphasize technique rather than specific equipment. We acquaint the student with the many considerations involved in picking the best way to do a task. Equipment is shown in its true position—as a tool. While technique and equipment are often inseparable, technique is the more important consideration.

First establish "what," then determine "how." "How much?" or "how large" follows from the handbooks and calculating machine.

Q: Is your book aimed primarily at students?

A: It is. But it will have wide acceptance elsewhere, we think.

Q: Who will want it?

A: Company presidents who were lawyers or bankers or otherwise technically untrained. Purchasing agents, salesmen, vice presidents, even brokers. In short, everyone who landed in the chemical business or on its fringes without the advantages of chemical engineering training.

Q: I'll lose my good standing in the book reviewers' union if I don't conform to standard operating procedure and report at least one typographical error. Are there any?

A: Yes. On page 479, "desiccant" is spelled wrong—twice.

Q: Thanks very much. And "desiccant" is spelled correctly in your book's fine, complete index.

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Subject	Summary	How to Order
Inorganics	A new look at an old segment of the industry. Covers the newest developments in strong oxidizers, oxidation, reduction. 8 pages.	Reprint No. 188. Editorial Dept., Chemical Engineer 330 West 42nd St., New York 36, N. Y. 25 cents.
Alloys	Thermodynamic relations with emphasis on principles. However, many data for specific systems are presented as examples. 160 pages.	"Thermodynamics of Alloys." By Carl Wagner. Addison-Wesley Press, Cambridge 42, Mass. \$6.50.
Acetaldehyde	Summarizes physical and chemical properties, points out its hazards. Emphasis is placed upon the caution which must be exercised in shipping and storage. 16 pages.	Chemical Safety Data Sheet SD-43. Manufacturing Chemists' Assn., 15th and H Sts., Washington 5, D. C. 30 cents.
Fluid Flow	Report on a fundamental study of fluid flow in regard to synthesis gas manufacture and heat transfer and pressure controls in synthetic liquid processes.	"Fluid Flow Through Packed and Fluidized Systems." By H. H. Storch. Bulletin 504, Bureau of Mines, Supt. of Documents, Washington 25, D. C. \$1.
Tall Oil	About 100 different processes recommended for tall oil refining with particular stress on methods used for industrial purposes. These methods are chiefly based on distillation, possibly combined with centrifuging of crystallized resin acids. 56 pages.	"Tall Oil Refining." By Ake Linder. Acta Polytechnic P.O. Box 5073, Stockholm 5, Sweden. 6 Swedish Kroner.
Alloys	Results from exposure tests on 71 low alloys structural steels exposed in industrial and marine atmospheres which lead to a new theory of the mechanism of rusting accounting for the improved corrosion resistance secured by the addition of nickel to steel.	"A Theory of the Mechanism of Rusting of Low Alloy Steel in the Atmosphere." By H. R. Copson. International Nickel Co., Dept. EZ, New York 5, N. Y.
Chromic Acid	Proper methods for shipping, labeling, storage, unloading and emptying containers. Personal protective equipment, employee education and instructions for physical examination and medical treatment. 12 pages.	Chemical Safety Data Sheet SD-44. Manufacturing Chemists' Assn., Woodward Bldg., 15th and H Sts., Washington 5, D. C. 25 cents.
Chemical Kinetics	Critically evaluated compilation of the available numerical data on rates and rate constants of homogeneous chemical reactions. Stress is laid throughout on experimentally ascertained facts and data depending on interpretations are generally not included. 731 pages.	"Tables of Chemical Kinetics, Homogeneous Reactions." NBS Circular 510. Supt. of Documents, Washington 25, D. C. \$4.
Bagasse	Annotated bibliography. Subject matter is divided into three sections: the use of bagasse as a source of pulp, paper and board; its use in the manufacture of plastics; miscellaneous chemical studies. 200 pages.	"The Utilization of Sugar Cane Bagasse." 2nd Ed. Compiled by Clarence J. West. Sugar Research Foundation, Inc., 52 Wall St., New York 5, N. Y. Gratis.
Insecticides	Listing of available translations of German patent applications representing the latest developments in the field of insecticides, pesticides, fungicides and weed killers. 8 pages.	Bulletin 63. Research Information Service, 53 Nassau St., New York 38, N. Y. Gratis.
Synthetic Fibers	Listing of available translations of a large number of patent applications and research papers of the foremost German manufacturers. Covers development from the war years up to 1951. 12 pages.	Bulletin 65. Research Information Service, 53 Nassau St., New York 38, N. Y. Gratis.

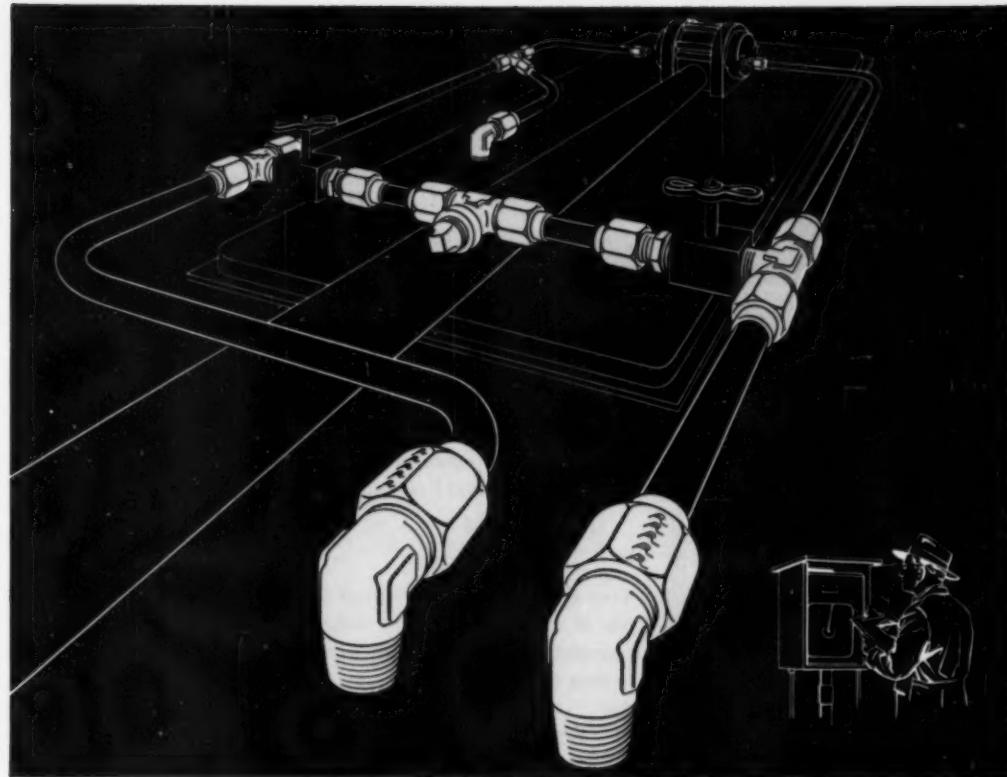


Illustration based on drawing of typical flow-meter assembly, widely used on pipelines.

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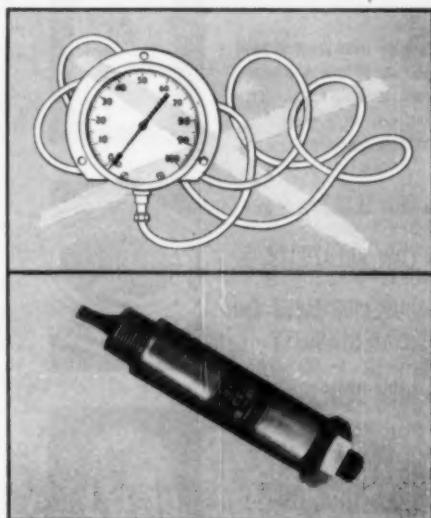
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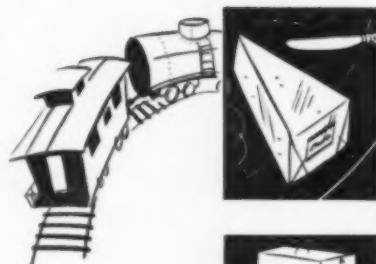
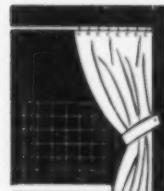
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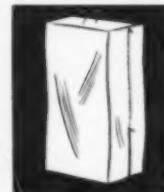


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Will Chemical Wages Play Tag?

Steel is "it" and chemicals can't run very fast or very far. Big government is the umpire. "The inevitable is inevitable."

The really big news for chemicals—for all industry—is the pattern of government behaviour in the steel dispute.

The decision of the Wage Stabilization Board to hike steel pay puts a new and disturbing note into the business outlook.

STEEL STORY

President Truman's dramatic seizure of the steel industry stole the headlines. But, much as we may applaud or abhor the President's action, the final verdict on that deed will be delivered by the Supreme Court.

The Wage Stabilization Board recommended that the steel workers be given a wage and fringe package which would boost industry costs—by 1953—by 26.4 cents an hour. The labor and public members of the Wage Board concurred in this recommendation. The industry representatives dissented vigorously—but they were outvoted.

Industry spokesmen argued that steel would need a price increase of \$12 a ton to offset increased costs arising from the Wage Board's decision. The Office of Price Stabilization, however, said that the Cepheus Amendment would limit any price rise to less than \$3 a ton.

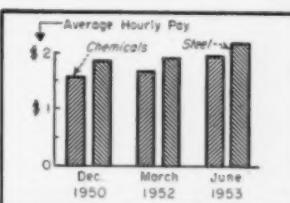
After the government had supported the pay boost without a compensating price increase, collective bargaining between labor and industry became futile.

FACTS ON WAGES

Immediately after seizure, the President attempted to justify his move in a radio address.

The President Said: "Under . . . [the Wage Board's] . . . recommendations, the steel workers would simply be catching up with what workers in other industries are already receiving."

The Facts Are: Under the recommendations the steel workers would—by June 1952—receive average pay of \$2.08 an hour. By June 1953, this would rise to \$2.14 an hour. The \$2.08 per hour is a wage higher than received by labor in any other industry except coal, oil and construction.



And in the auto industry, where pay has traditionally been higher than in steel, the average hourly wage will only be about \$2.02 in June 1952, according to present contract provisions.

The Wage Board's recommendations would mean a total gain for steel workers of 37.5 cents per hour, or 22 percent, since January 1950. In this same period—the period to which wage stabilization rules apply—the average wage increase for all manufacturing has been about 15 percent.

It is clear that by upsetting the existing wage pattern the Wage Board's decision will open the floodgates for another substantial round of wage increases.

CHEMICAL WAGES

Take the case of chemicals.

In December 1950, hourly pay in chemicals was \$1.58. That meant that steel workers—with average hourly pay of \$1.83 at the time—had a 25-cent differential over chemicals.

In November 1951, wages in chemicals had risen to \$1.65 an hour. Since steel wages were then at \$1.88 an hour the differential was still almost 25 c.

Chemical wages will be up for discussion shortly. If labor in chemicals maintains its rate of 23-25 cents an hour less than the steel workers, industry leaders are going to be faced with some stiff demands. Chemical workers will want a pay hike of 17 cents an hour by June 1952, 23 cents by 1953.

FACTS ON PROFITS

The President Said: "The companies could absorb this wage increase entirely out of profits. . . . The steel industry has never been so profitable as it is today."

The Facts Are: (1) In 1951, the steel industry's profits before taxes were \$1.8 billion, or about \$18.50 per ton. These were the highest pretax profits ever made by the industry. (2) But the all-important after tax profits of \$635 million were off 13 percent from the 1950 total. Profits per ton after taxes were \$6.50—23 percent less than in 1950.

Meanwhile, stockholders in steel spent a great deal to expand capacity. It costs about \$200 per ton to build new steel capacity. If the lid is kept on steel prices and the wage boost rammed home, steel profits per ton, after taxes, will sink to about \$5.30. The return on the new investment will be 2.7 percent.

This is less than the return on U. S. Savings Bonds, which carry no risk.

CAPITAL INVESTMENT

Government intervention in steel strikes directly at capital expenditures. And the negative effect on capital spending will not be confined to the steel industry.

Steel profits—the driving force behind industry capital outlay—will be squeezed. It will be a double squeeze. Not only will direct costs go up, but when wage boosts spread and other industries hike prices, the steel companies will find that it will have to pay more for coal, chemicals, transport.

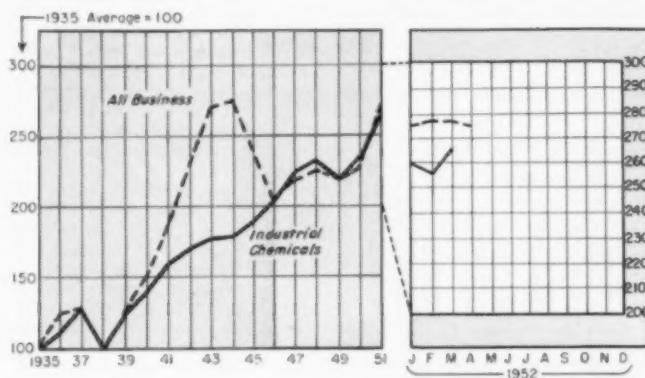
Even a substantial price increase in steel and other industries will not be able to repair the damage caused by the Wage Board decision. Industry prices, generally, are not pressing vigorously against price ceilings. In most cases businessmen are stretching and straining—to no avail—in an effort to sell their products at prices as high as the ceiling.

When the profit outlook sags, capital investment falls off. And a business recession has always gone hand in hand with a fall in capital outlay. By its actions in steel, the government is raising costs and darkening the profit outlook precisely at the time that industry needs some encouragement to go ahead with the very high and daring capital outlay plans it revealed to the McGraw-Hill Department of Economics at the time of its most recent survey of business' plans.

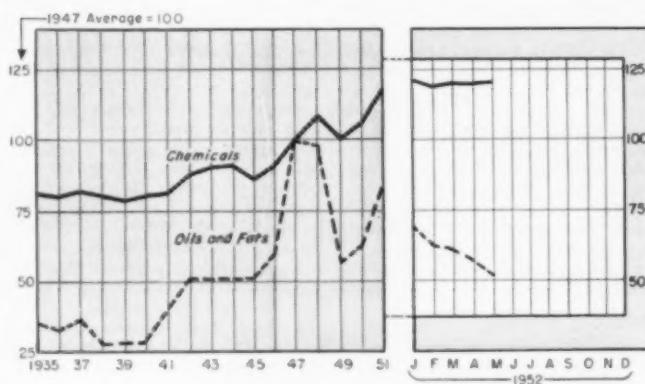
It all adds up to the fact that the Wage Board's decision puts a seriously destructive new element into the business outlook. It increases substantially the chances of having a business setback in 1953.

Process Industry Trends

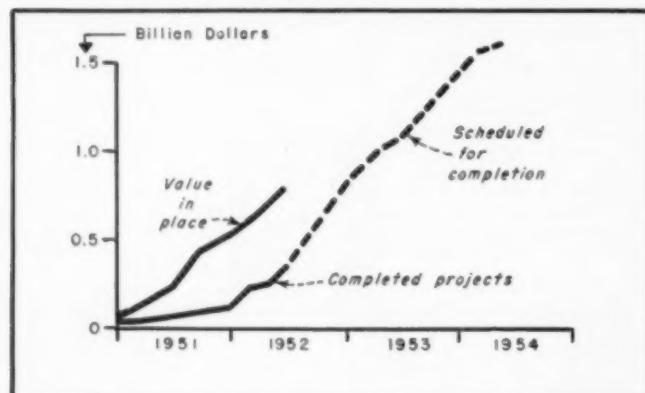
CONSUMPTION



PRICES



HIGHLIGHT OF THE MONTH



Second Quarter Report

Chemical industry expansion, aided by certificates of necessity, ranks second only to the big iron and steel program. New facilities for the chemicals industry currently totals about \$1.6 billion. These cover a wide range of products.

In 1951, the industry did not get its full allotment of materials and equipment but this situation will be considerably easier this year.

The expansion programs for the production of alkalis and chlorine, industrial inorganic chemicals and industrial organic chemicals are scheduled to be completed by the end of 1953 or early in 1954.



How do you measure the look in a puppy's eye?

The preliminary precautions have been taken. A well-recommended kennel. A healthy litter. A breed that takes well to youngsters.

Now it's up to the boy to choose.

How will he decide? Perhaps by the look in a puppy's eye.

Chances are, you'll be buying Multiwalls soon again. You've done as every good buyer does. You've considered the reputation of the various suppliers. You've investigated the quality of their product. You've set down your specifications to the last fraction.

Now you pause to think again of the fellow who will make the final choice—your customer. How will he decide? One

consideration may well be "the look in a puppy's eye." To say it another way, the sales appeal of your package.

Men who know Multiwalls...who buy more than 85 per cent of all Multiwalls made...give great weight* to good printing and design.

Union's art directors have concentrated experience. They know how to give your Multiwall package the look it needs to stand out among competition. Volume purchasers of Multiwalls recognize this. They are calling on Union for a greater share of their Multiwall needs.

More so every day...

IT'S UNION FOR MULTIWALLS



*August, 1951 research study.

UNION BAG & PAPER CORPORATION • WOOLWORTH BUILDING, NEW YORK 7

New Construction

Proposed Work

Ariz., Florence—West Coast Pipe Line Co., c/o J. R. Bradley, 4012 Marquette St., Dallas, Tex., plans to construct a 15,000 bbl. daily capacity crude oil refinery. Estimated cost \$2,750,000.

Ga., Savannah—Southern Paperboard Corp., Port Wentworth, plans to construct additions to its plant. Estimated cost \$5,600,000.

Ia., Davenport—Dewey Portland Cement Co., Davenport, John H. Bickert, Dist. Mgr., plans to enlarge its plant. Estimated cost \$2,000,000.

Mich., Kalamazoo—Upjohn Co., Kalamazoo, plans to construct a Cortisone plant, laboratory addition and antibiotics plant. Estimated cost \$3,500,000, \$4,300,000 and \$3,400,000 respectively.

O., Cincinnati—Emery Industries, 4300 Carew Tower, Cincinnati, plans to construct an addition to its chemical plant at 4900 Este Ave. Estimated cost \$2,000,000.

Okla., Miami—B. F. Goodrich Co., 500 South Main St., Akron, O., plans to construct a tire manufacturing plant here. Estimated cost \$3,000,000.

W. Va., New Martinsville—Columbia Southern Chemical Co., New Martinsville, plans to construct plant additions. Estimated cost \$8,500,000.

Contracts Awarded

Calif., San Jose—International Minerals & Chemical Corp., 1931 South Monterey St., has awarded the contract for a plant addition to O. E. Anderson, P. O. Box 251, San Jose, at \$135,798.

Fla., Foley—Buckeye Cellulose Corp., subsidiary of Procter & Gamble Co., Cincinnati, O., has awarded the contract for a pulp plant to H. K. Ferguson Co., 1783 East 11th St., Cleveland, O. and Duval Engineering & Contracting Co., 1746 East Adams St., Jacksonville. Estimated cost \$20,000,000.

Ga., Brunswick—Hercules Powder Co., Wilmington, Del., has awarded the contract for design and construction of plant to convert by-product hydrochloric acid to chlorine to H. K. Ferguson Co., 1783 East 11th St., Cleveland, O. Estimated cost \$1,000,000.

Ill., Lemont—Alexander Chemical Corp., 35 E. Wacker Dr., Chicago, has awarded the contract for a chlorine bottling plant to F. Dalpo & Sons, 30 Stephen St., Lemont. Estimated cost \$125,000.

Ky., Cynthiaville—Ashland Oil & Refining Co., Cynthiaville, has awarded the contract for plant additions to Catalytic Construction Co., 1528 Walnut St., Philadelphia, Pa. Estimated cost \$250,000.

Ky., Louisville—Corhart Refractories Co., 1600 West Lee St., has awarded the contract for a plant to manufacture linings for steel furnaces to Sullivan & Cozzart, 822 W. Kentucky St. Estimated cost \$1,000,000.

Ia., Destrehan—Pan American Southern Corp., Destrehan, has awarded the contract for design and construction of fluid hydroforming

	Current Projects		Cumulative 1952	
	Proposed Work	Contracts	Proposed Work	Contracts
New England.....		\$450,000	\$6,000,000	\$2,107,000
Middle Atlantic.....	20,900,000	33,350,000	19,880,000	
South.....	\$14,300,000	24,250,000	29,000,000	97,100,000
Midwest.....	12,200,000	1,100,000	31,100,000	63,507,000
West of Mississippi.....	5,000,000	32,725,000	366,923,000	187,170,000
Far West.....	2,750,000	2,126,000	9,069,000	23,089,000
Canada.....			135,475,000	18,588,000
Total.....	\$35,050,000	\$81,786,000	\$789,882,000	\$413,332,000

plant to The M. W. Kellogg Co., 225 Broadway, New York, N. Y. Estimated cost \$500,000.

Md., Halethorpe—Kaiser Aluminum & Chemical Corp., 1924 Bway., Oakland, Calif., has awarded the contract for an aluminum extrusion plant to Kaiser Engineers, Inc., 1924 Bway., Oakland; equipment including two presses to Loewy Construction Co., 570 Lexington Ave., New York, N. Y. Estimated cost \$9,000,000.

Mass., Harvard—Weston Laboratories, 410 Glen Rd., Weston, have awarded the contract for a laboratory to W. G. Tingley, 410 Glen Rd. Estimated cost \$100,000.

Mo., Trenton—Thurston Chemical Co., Miners Bank Bldg., Joplin, will construct a fertilizer plant with own forces. Estimated cost \$100,000.

N. J., Egg Harbor Township—Lenox, Inc., Meade St., Trenton, has awarded the contract for a chime manufacturing factory on Tilton Rd. to Ole Hansen & Son, Inc., Pleasantville. Estimated cost \$2,500,000.

N. Y., Willsboro—Cabot Minerals c/o Charles T. Main, Inc., Engr., 80 Federal St., Boston, Mass., has awarded the contract for a factory to Wagaman & Colver Constructors, Inc., 160 Glen St., Glens Falls. Estimated cost \$250,000.

O., Chillicothe—Mead Corp., 8th and Hickory Sts., has awarded the contract for a research and development laboratory to Maxon Construction Co., 131 N. Ludlow St., Dayton. Estimated cost \$1,000,000.

O., Fostoria—Swift & Co., 4115 S. Packers St., Chicago, Ill., has awarded the contract for a solvent extraction type soybean oil to replace present expeller type unit to Blaw-Knox Construction Co., Farmers Bank Bldg., Pittsburgh, Pa. Estimated cost will exceed \$200,000.

Okla., Cushing—Midland Cooperative Refinery Co., Cushing, has awarded the contract for a catalytic cracking unit and storage plant to M. W. Kellogg Co., Kennedy Bldg., Tulsa, and 225 Bway., New York, N. Y. Estimated cost \$3,500,000.

Pa., Neville Island—Pittsburgh Coke & Chemical Co., Neville Island, has awarded the contract for a blast furnace, coke and chemical plant (35 coke ovens) to Koppers Co., Inc., Koppers Bldg., Pittsburgh. Estimated cost \$9,150,000.

Tenn., Memphis—Delta Refining Co., W. Mallory Ave., has awarded the contract for a catalytic cracking refinery, crude oil unit, etc., to Ajax Construction Co., 321 W. Douglas St., Wichita, Kan. Estimated cost \$1,500,000.

Tex., Baytown—Humble Oil & Refining Co., 1216 Main St., Houston, has awarded the contract for a petrochemical plant and alkylation refining unit to C. F. Braun & Co., City Natl. Bank Bldg., Houston. Estimated cost \$5,750,000 and \$1,750,000 respectively.

Tex., Beaumont—Magnolia Petroleum Corp., Beaumont, 25,000 bbl. daily capacity feed preparation system at refinery to hike jet fuel and high octane aviation gasoline production. Work is being done by owner. Estimated cost \$2,225,000.

Tex., Bronte—Lone Star Producing Co., 1915 Wood St., Dallas, will construct gas plant to have daily capacity of 30,000,000 cu. ft. per day. Work will be done by owners. Estimated cost \$3,000,000.

Tex., Freeport—Dow Chemical Co., Midland, Mich., has awarded the contract for a laboratory and research center to Southwestern Construction Co., 4949 Rusk St., Houston. Estimated cost \$2,600,000.

Tex., Garland—DeSoto Paint & Varnish Co., 752 S. Somerville St., Memphis, Tenn., has awarded the contract for a paint manufacturing plant to F. T. Thayer, Jr., Box 186, Garland. Estimated cost \$1,000,000.

Tex., Houston—Humble Oil & Refining Co., Humble Bldg., Houston, has awarded the contract for a research laboratory to Linbeck Construction Corp., 3616 W. Alabama St., Houston. Estimated cost \$2,750,000.

Tex., Odessa—Stanolind Oil & Gas Corp., Odessa, will construct a sulphur recovery plant unit. Work will be done by purchase and hire. Estimated cost \$1,250,000.

Tex., Pampa—Celanese Corp. of America, Pampa, will build chemical plant. Work is being done by owners. Estimated cost \$2,800,000.

Tex., Rankin—Wilshire Oil Co. and Lone Star Gas Co., 1915 Wood St., Dallas, will build natural gas plant. Work will be done by owners. Estimated cost \$2,500,000.

Tex., Texas City—Monsanto Chemical Co., Texas City, will build addition to styrene monomer plant. Work is being done by owners. Estimated cost \$3,500,000.

Vt., Windsor—Goodyear Tire & Rubber Co., Acme St., has awarded the contract for a 1 story factory to Trumbull-Nelson Co., 11 Lebanon St., Hanover, N. H. Estimated cost \$350,000.

Wash., Everett—Everett Pulp & Paper Co., Everett, has awarded the contract for enlarging its pulp and paper plant to Howard S. Wright & Co., 407 Yale Ave., N., Seattle. Estimated cost \$2,000,000.

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CE-5

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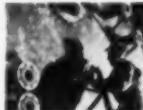
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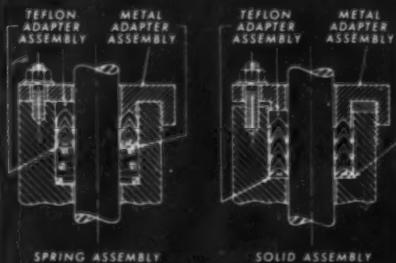
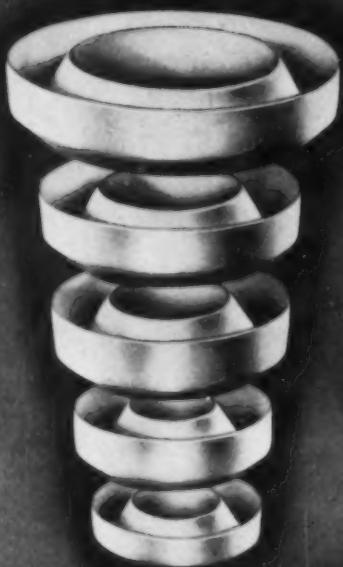
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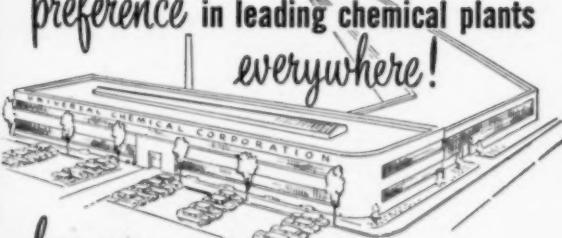
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"John Crane" Teflon "C-V" Rings are used in sets, the number of rings depending upon the stuffing box length and pressure encountered. In all cases, a minimum of two rings are recommended for a stuffing box, together with male and female adapters.

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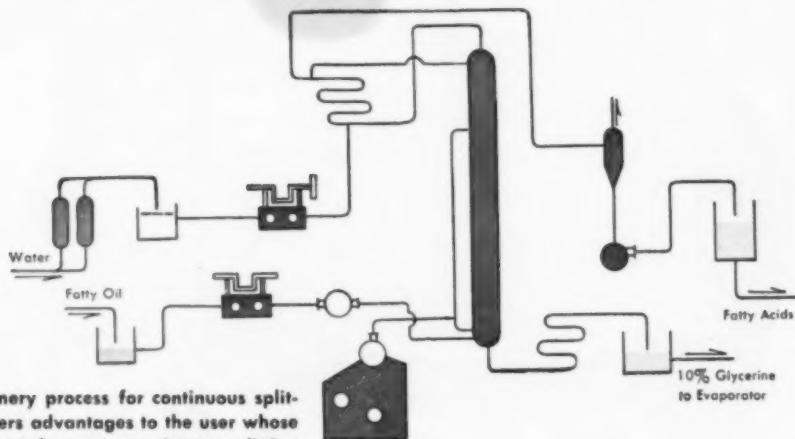
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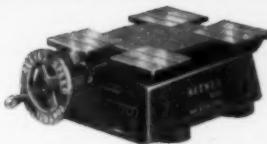
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converts any standard constant speed motor
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1. REEVES Motor Base provides sliding platform for motor. Handwheel or push-button control increases transmitted speed by moving motor toward driven machine, decreases speed by reversing the operation.



2. Disc Assembly connects directly to motor shaft. Assembly consists of two facing cone-shaped discs—one sliding laterally—and compression spring for mounting as a single unit on motor extension shaft.



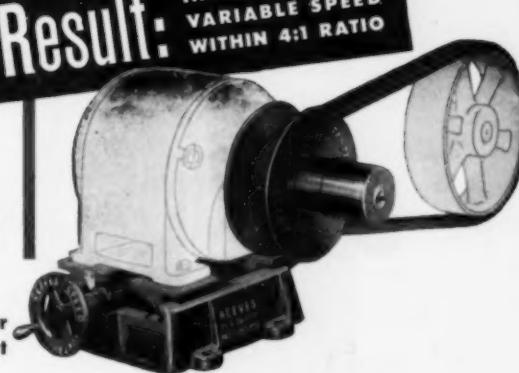
3. Special V-Belt hooks up unit with driven machine. Belt fits between discs and over pulley on power input shaft of driven machine. Belt is adjusted to minimum center.

Unit instantly delivers any desired speed over entire range and maintains that speed without fluctuating even a fraction of an rpm.

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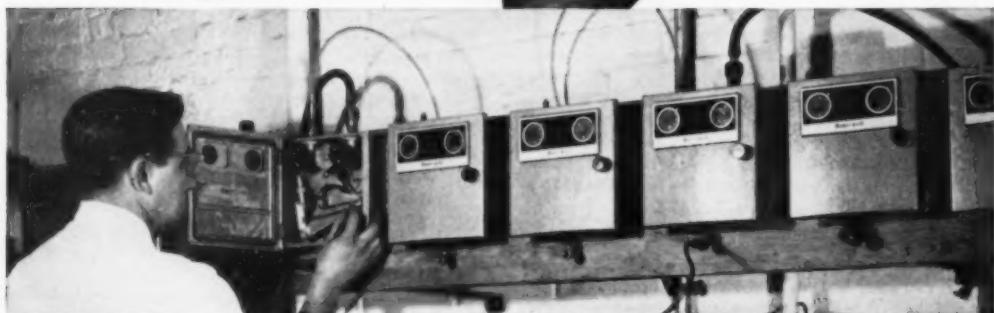
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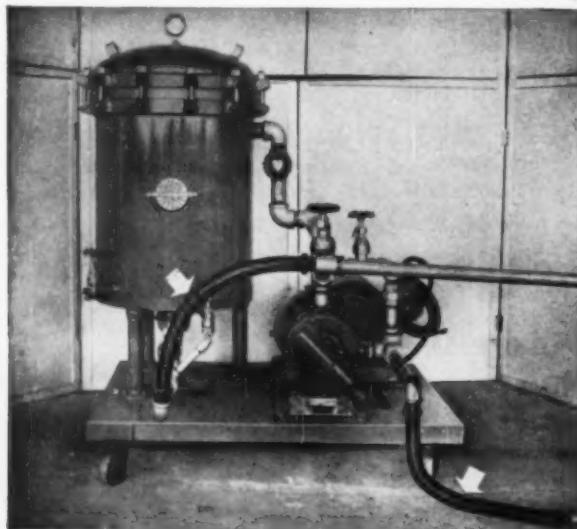
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must **flex,**
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These three products have only one thing in common—piping that moves, bends or vibrates. And for all three, there's a type of American Flexible Metal Hose or Seamless Flexible Metal Tubing to meet the need.

There's a type of versatile, flexible American Metal Hose to improve your product's performance . . . to convey liquids, gases or semisolids under severe conditions of temperature, pressure . . . to minimize vibration, to connect misaligned piping and ports. Let us send you Bulletins SS-50 and CC-300 with the full details. The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd. Distributors in all key cities.



wherever connectors must move...

American

Anaconda
American Metal Hose

FLEXIBLE METAL HOSE AND TUBING

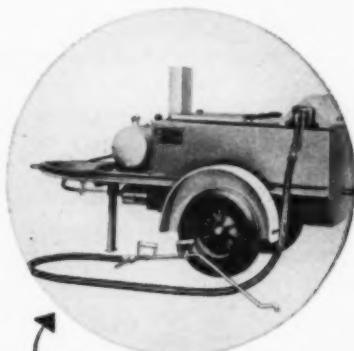


vapor steerer

American $\frac{5}{8}$ " I.D. Aluminum Flexible Metal Hose provides a convenient adjustable duct for directing healing vapor from this "Vapor All" Vaporizer Inhalator to where it is needed. It's tight, light, sanitary and rust proof. Courtesy Sanit-All Products Corporation, Greenwich, Ohio.

inlet-outlet

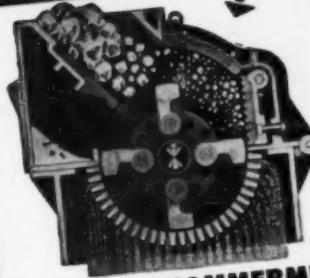
American 1" I.D. Steel Seamless Flexible Metal Tubing connects this filter made by the Sparkler Mfg. Co., Mundelein, Ill., at inlet and outlet, with rigid pipe leading to vat or other liquid container. Tight and strong, it makes connecting and disconnecting the unit quick and easy—minimizes vibration while in operation.



tar baby

Pouring hot tar for roadway repairs is usually a slow and messy procedure—except when you do it this way with a mobile tar kettle such as this made by Littleford Bros. of Cincinnati, Ohio. Here the tar is dispensed by pump through a 1" I.D. armored and insulated American Flexible Tar and Asphalt Hose connected to a nozzle. It's a good example of the versatility of American Flexible Metal Hose and Tubing in handling almost anything that flows.

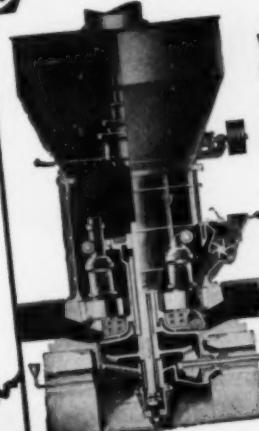
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WE CAN GRIND IT!



WILLIAMS HAMMERMILLS

Heavy duty for crushing and grinding rock phosphate, gypsum, limestone, shale, bauxite, asbestos rock and other chemical and fibrous materials to small sizes in one operation.

Many sizes to choose from and capacity is unusually high and power involved and maintenance extremely low.

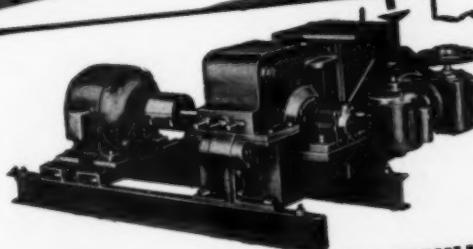


WILLIAMS ROLLER MILLS WITH AIR SEPARATION

Many materials are now economically pulverized with the Williams Roller Mill. Fineness quickly changeable from 40 mesh to 400 mesh and materials may be dried and ground simultaneously.

Remarkable records are being made on insecticide mixes, pigments and dry colors and barytes, phosphate, limestone, etc.

WC81-BC



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Dustless fine grinding, 200 to 325 mesh, without the use of fans, cyclones or separators. Will also grind wet and sticky materials. Easy to install and inexpensive to operate. Variable speed control on feeder permits grinding of different kinds of materials.

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*WILLIAMS TESTING...MEANS GUARANTEED PERFORMANCE

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CRUSHERS GRINDERS SHREDDERS
LARGEST MANUFACTURER OF HAMMERMILLS IN THE WORLD

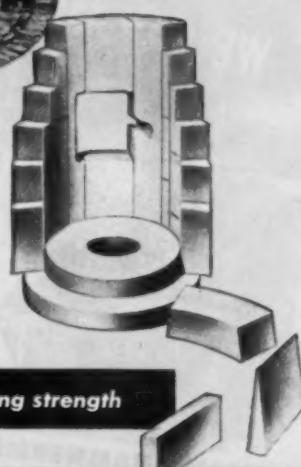




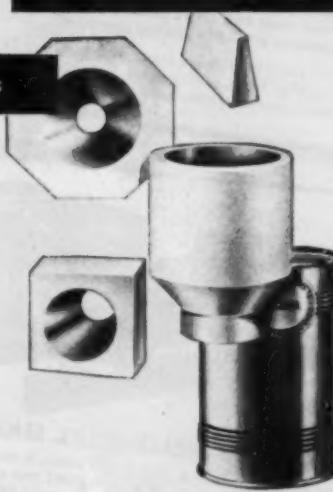
ALCOA Alumina

gives "SHAMVA" MULLITE
refractories:

GREATER load bearing strength



LESS re-heat shrinkage



HIGHER refractoriness

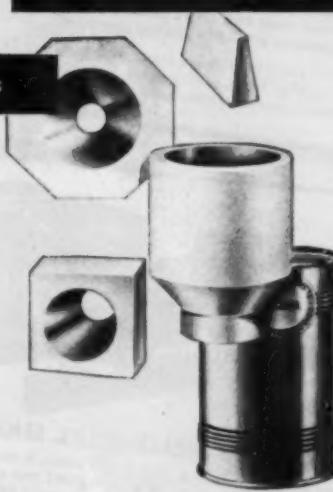
To give these three qualities to their products, the Mullite Refractories Company, Shelton, Connecticut, adds ALCOA Alumina to their mix. Now, Mullite super-refractories come in three grades, containing 62%, 67% and 72% alumina respectively.

This company reports the average service life of alumina refractories at more than double that of ordinary grades and in specific applications more than 6 times. Before the addition of ALCOA Alumina, brick deterioration began after 40-60 heats. Now Mullite refractories will withstand 270-285 heats before evidence of breakdown.

This is an outstanding testimonial to the value of ALCOA Alumina as a *life-giving* constituent of refractory brick. Down time is considerably reduced, saving untold dollars in production loss as well as labor and material costs to rebuild. Moreover, alumina refractories, by keeping furnaces in continuous operation *longer*, give increased tonnages and more uniform operating conditions.

If high-temperature operations have you stymied, investigate alumina super-refractories. We will be glad to refer you to reliable sources of supply. Write to:

ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION
602E Gulf Building, Pittsburgh 19, Pa.



Alcoa Chemicals

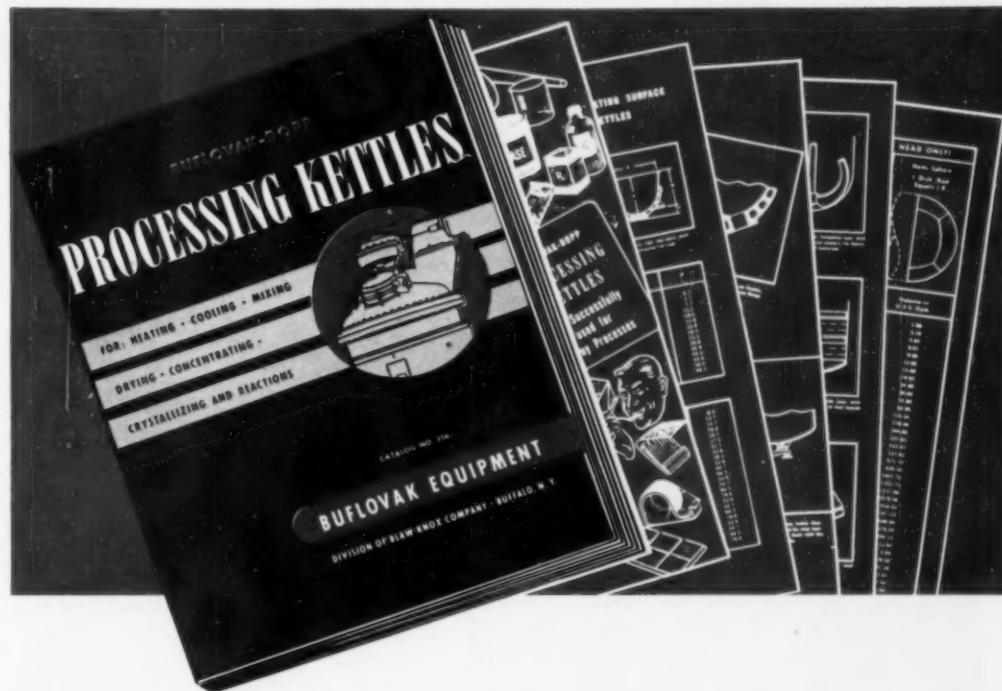


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STOKES MICROVAC PUMPS...are basic to Vacuum Processing

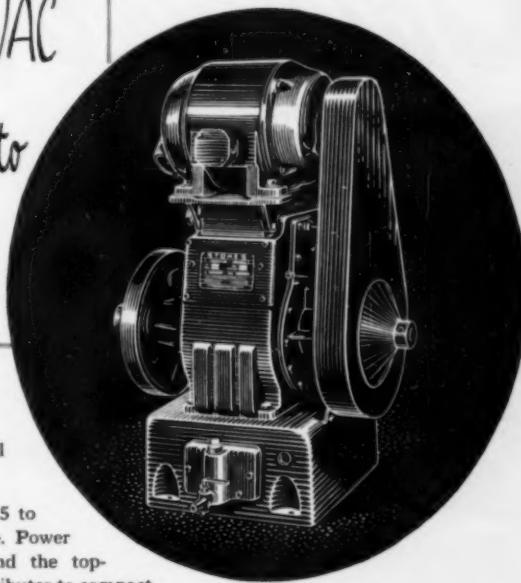
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WILSON TP-301 CLEANER



This high speed tube cleaner is designed to increase output and minimize down-time. The improved Model TP-301 is the only tube cleaner which can remove deposits from completely plugged heat exchanger tubes . . . and other fouled straight tubes heretofore not considered practical to clean.

Many improvements, resulting from years of field experience, have been built into the new TP-301 cleaner.

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- **SHORTER**—only 13" overall.
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- **COSTS LESS** than previous models.

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Send for Bulletin giving complete details on this man-hour and money-saving tube cleaner

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TUBE CLEANERS • TUBE EXPANDERS

Koncentrik DOUBLE-SEAL FITTINGS

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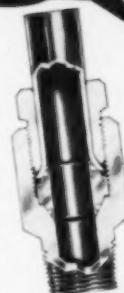
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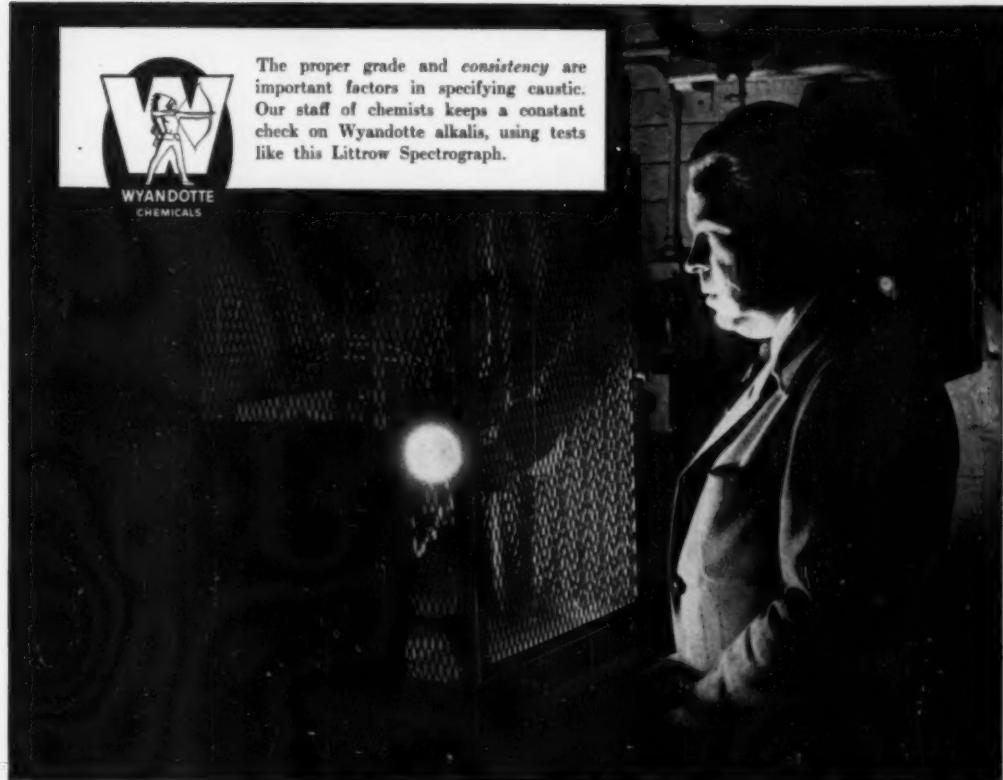
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These tests PROVE THE CONSISTENCY of every grade of Wyandotte Caustic!

Complete analyses of Wyandotte alkalis (read how you can make them) assure you of consistency and other advantages.

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Wyandotte Mercury Cell Caustic, for instance, meets the most *exacting* specifications. It's as pure as reagent grades! One manufacturer used to purify caustic in his plant

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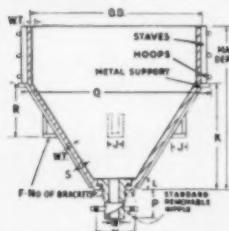
From TOPS Where tanks are vented to the atmosphere, four types of covers may be obtained. HAVEG can be machined and repaired readily so that pipe connections, manholes, changes to the system present no problem to the installation and maintenance crew.

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Cone Bottom Tank for applications requiring complete drainage.

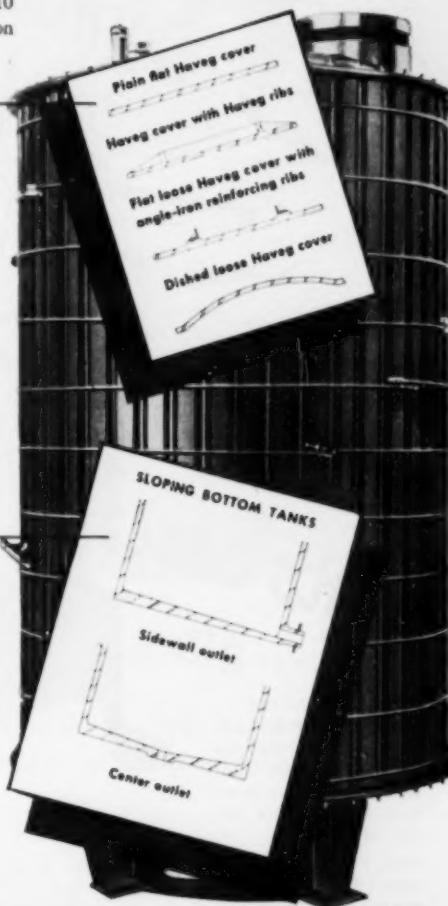
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COMPANY**

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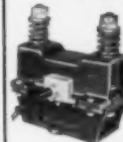
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"Pulsating Magnet"

Electric Vibrators

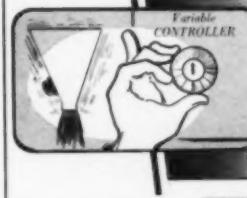
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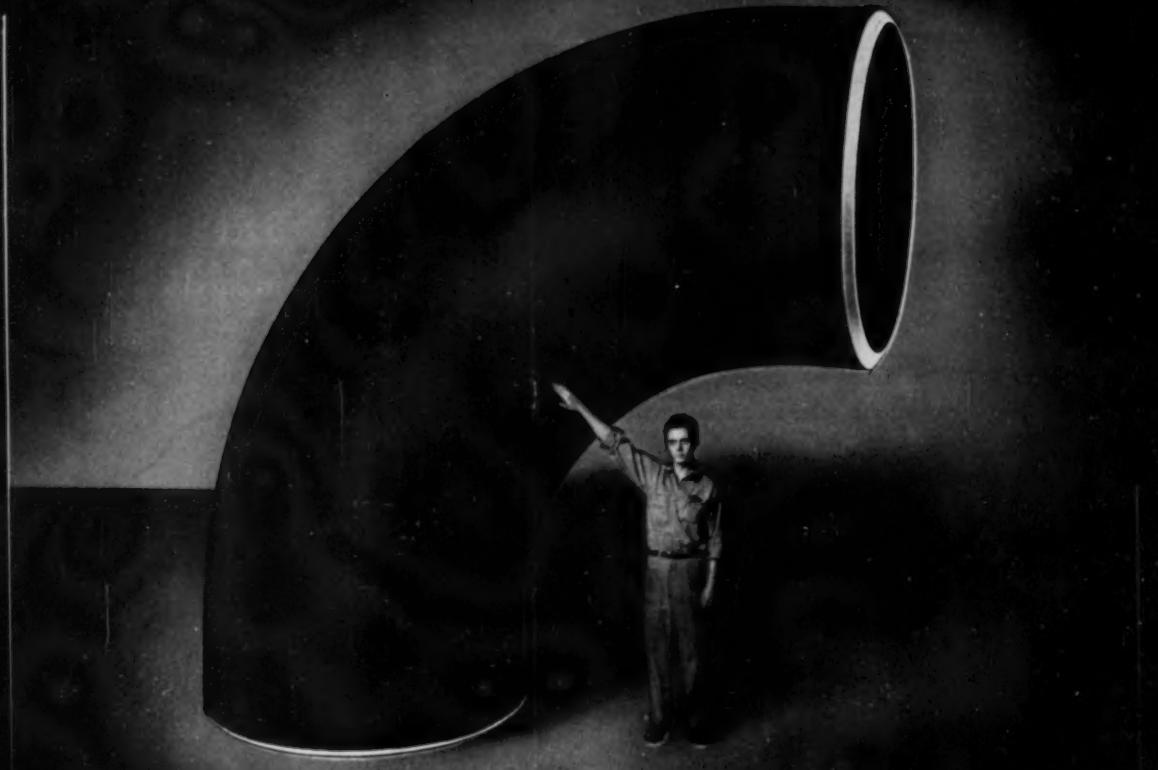
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Takes the place of a straight size elbow and a reducer. Eliminates one weld, reduces pressure drop, easier to insulate. Sizes to 12", reductions to half size.

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The one thing that will help reduce these shutdowns is more care exercised in the selection of materials that go to make up the equipment. Every part must function with dependability. And what part demands more dependability than the condenser tubes?

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These condenser tubes are available in any copper alloy that you may require to meet your particular conditions. Our engineers are always ready to consult with you on the most suitable alloy to use in your particular application.

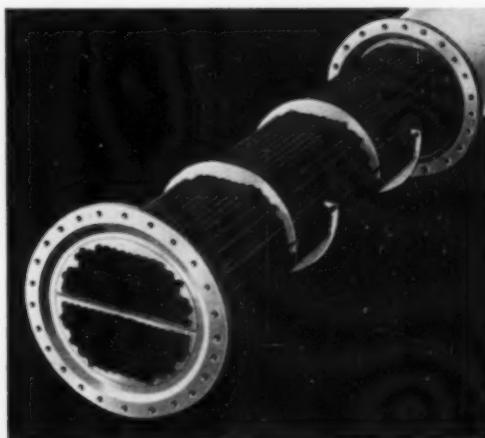
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FOR EVERY
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A complete steam plant backed by undivided responsibility. Shipped completely assembled. More than 80% thermal efficiency guaranteed. 4-pass design provides 5 sq. ft. of heating surface per b.h.p. Built-in induced draft eliminates need of expensive chimney. Simple installation. Clean, quiet operation. Heavy-duty construction assures long-lived dependability.

Superior Steam Generators are manufactured in 18 sizes from 20 to 600 b.h.p. for pressures up to 250 p.s.i. or for hot water heating.

For complete details, write for Catalog 322

SENIOR COMBINATION STEAM GENERATOR

Factory: Emmaus, Pa.

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THE
SUPERIOR
STEAM GENERATOR

New Portable Field Manometer

by **MERIAM**

For Checking Calibration of Gas Orifice Meters in the Field...

Filling a long-felt need, this unit offers many advantages.

All stainless steel with precision bore tubing. Sliding magnifier for readings down to 0.2" of water — and mirror that avoids parallax in reading.

Scale is graduated in inches of water pressure, using mercury calibrated dry. Range is 0-110" of water. Valve at instrument well and fitting at top of indicating tube prevent loss of mercury when manometer is transported.

Provided with bubble level and universal ball and socket type clamp which permits mounting to meter piping — up to $\frac{1}{2}$ " size. Complete assembly — including mercury and length of rubber tubing — is housed in metal case 5" wide, 3" high, and 14" long — total weight, $7\frac{1}{2}$ pounds.

Can be completely disassembled for cleaning. Precision-built throughout — typical of all Meriam instruments. Ask for Catalog Sheet B2862.

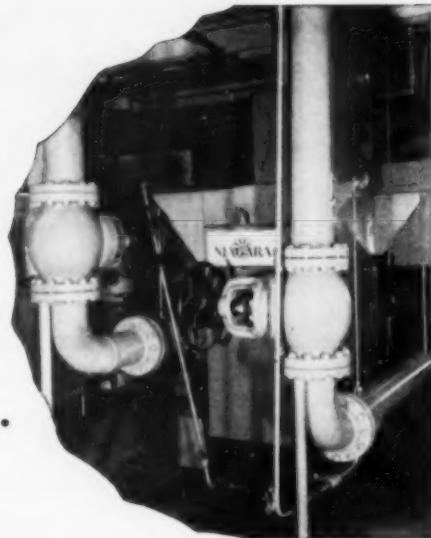
Handy Portable Field
Manometer weighs
only 3 $\frac{1}{2}$ pounds.

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How to get drier or cooler gases . . .



NIAGARA AERO AFTER COOLER cools a compressed gas, or air, below the temperature of the surrounding atmosphere, thus preventing the condensation of moisture in your lines. The gas will contain only half of the moisture left in it by conventional methods. Even drier gas can be produced if you require it.

In working with controlled atmospheres of inert gases to prevent undesired reactions, this dryness of the gas at low cost is a great advantage. The cost of the Niagara method is low because it uses evaporative cooling, saving 95% of the cost of cooling water (and its piping and pumping). This direct saving of cost pays for the Niagara cooler in less than two years.

If you use compressed air to operate tools or pneumatic equipment you save much in water and oil damage to tools and equipment, and in water damage to materials by using the Niagara Aero After Cooler.

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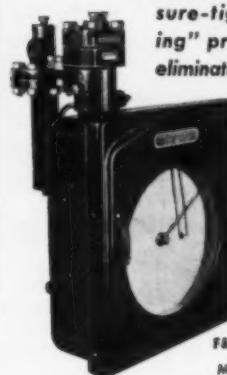
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MAGNABOND magnetic coupling

A BASIC ADVANCE IN INSTRUMENTATION

...increases Mercury
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MANOMETER

The F&P MERCURY MANOMETER flow meter utilizing the patented separation-proof MAGNABOND magnetic coupling brings added safety, accuracy, and maintenance-free operation to variable-head metering. The frictionless MAGNABOND coupling transmits the manometer float position without need for pressure tight bearings, lubricants, maintenance.

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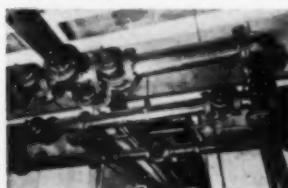
CANNOT WEDGE IN SEAT



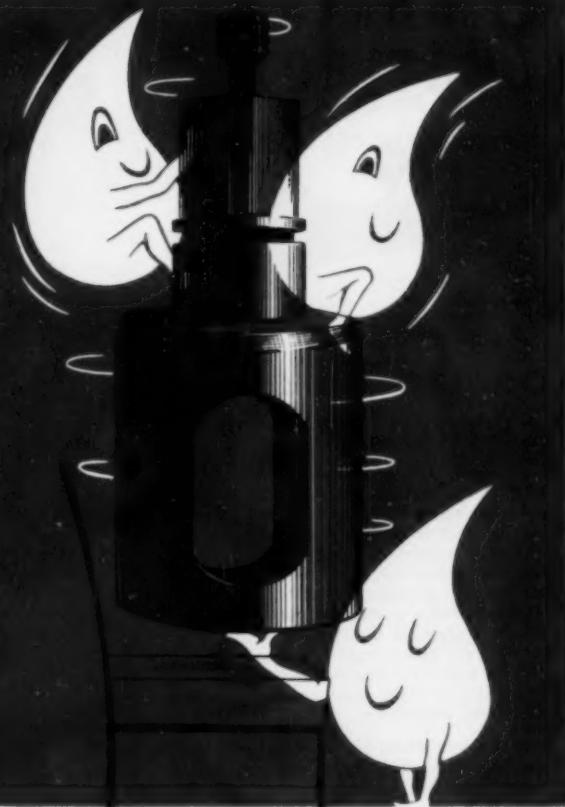
IN CHEMICAL PLANTS O.C.F. "full pipe area" valves offer no obstruction... full flow for abrasives, suspensions.



IN THE PETROLEUM INDUSTRY where seconds count in loading and unloading, O.C.F. Valves give fastest possible flow.



IN SEWAGE PLANTS obstructions are sheared by the knife-edge action of the O.C.F. CYLINDRICAL Plug.



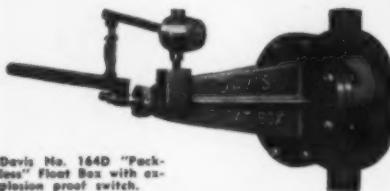
O.C.F. CYLINDRICAL Lubricated Plug Valves have no wedging effect. This plus the quick, quarter-turn shut-off feature gives you safe, sure, split-second control even at capacity flow. Made to last, O.C.F. Valve bearing surfaces are lubricant sealed. Substantial reasons for the absolute leadership of Full Pipe Area O.C.F. Valves.

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Write for Catalogue 4-CM, American Car and Foundry Co., Valve Division, 1501 E. Ferry Ave., Detroit 11, Mich.

Representatives in 50 Principal Cities

DAVIS FLOAT BOXES



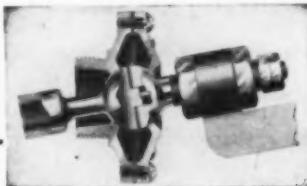
Davis No. 164D "Pack-less" Float Box with explosion proof switch.

FOR LIQUID LEVEL CONTROL SERVICE

DAVIS Float Boxes are used in connection with closed tanks where fluctuation of the fluid level within the tank is the governing factor in the control of all types of electrical switches, control valves, pilot valves (for operation of diaphragm motor valves), motors and other equipment. Davis fluid control equipment also includes internal float units for direct or pilot operation. Whatever your requirement may be, Davis can supply you with a combination of float box and control valve to make your control accurate, positive, and dependable.

Drop us a card today for detailed information on the Davis line. Ask for Bulletin 101AA.

DAVIS DIA-BALL TRANSMISSION UNIT

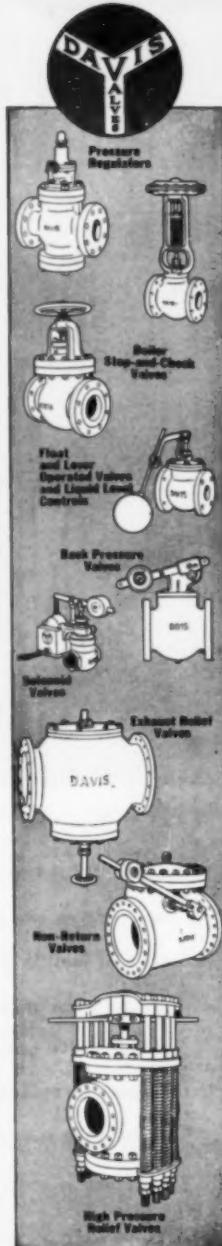


A patented, leakproof, corrosion resistant packless assembly eliminating the packing box on Davis Float Boxes and Control Valves. Especially recommended for vacuum service or for use with volatile and inflammable fluids where a packing box is objectionable because of leakage. For pressures up to 250 lbs. and temperature up to 300° F.

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- ELIMINATES trips to the laboratory.

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PRICE \$125.00

Instrument size: 3 x 5 $\frac{1}{2}$ x 2 $\frac{1}{2}$ inches

Case size: 3 $\frac{1}{4}$ x 6 $\frac{1}{2}$ x 4 $\frac{1}{4}$ inches

Weight with accessories: 3 lbs.



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combining Heater and Thermostat in one unit
ready to go on your Jobs!

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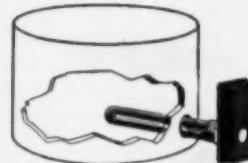
Electric Heat for Modern Industry



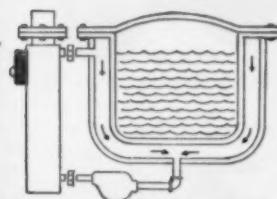
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to fit your
Needs Exactly**



Chromalox Immersion Heaters with built-in thermostats for portable or permanent use. Drawing illustrates Immersion Unit, equipped with sludge-legs, installed over the side of the tank for direct heating. Available in various metal sheaths to resist the corrosive action of the liquid compounds.



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Chromalox Circulation Heaters give accurate, controlled heat up to 750° F. for heating Dowtherm, Aractor or heat transfer oils. Other uses include water heating applications such as steam boilers and accumulators, kettles, tanks and processing equipment, preheating fuel oils, heating air, nitrogen and other gases, drying steam, plastic powders, etc.

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offers over 20,000 different
"custom-made" assemblies on
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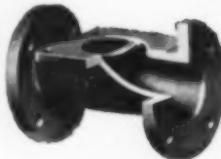
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Methods of operation for Hills-McCanna Valves include hand-wheel and lever operators, sliding stem, air and hydraulic cylinders, diaphragm motors and electric motors in a variety of types.



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Diaphragms, the heart of Hills-McCanna Valves, are offered in the widest choice to best suit your individual needs; 5 types of rubber, 3 of Neoprene plus Hycar, butyl, Tygon, Compar, special polyethylene and Kel-F.



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Three ways

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J-50521

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You can't measure a working vacuum by pressure alone because time also is a big factor in any vacuum processing operation. To provide these two essentials of high vacuum — (1) the required low absolute pressure (2) in the shortest possible time — is the job for fast, dependable Kinney High Vacuum Pumps.

Fast — Kinney High Vacuum Pumps have the ability to save processing time by speeding up the tempo of your vacuum operations.

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Remember, there's a Kinney Pump for every vacuum requirement, from the midget 2 cu. ft. per min. pump to the new giant 1600 cu. ft. per min. model. Send coupon today for new Kinney Bulletin V-51B. KINNEY MANUFACTURING CO., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Philadelphia, Houston, New Orleans, San Francisco, Seattle, Los Angeles.

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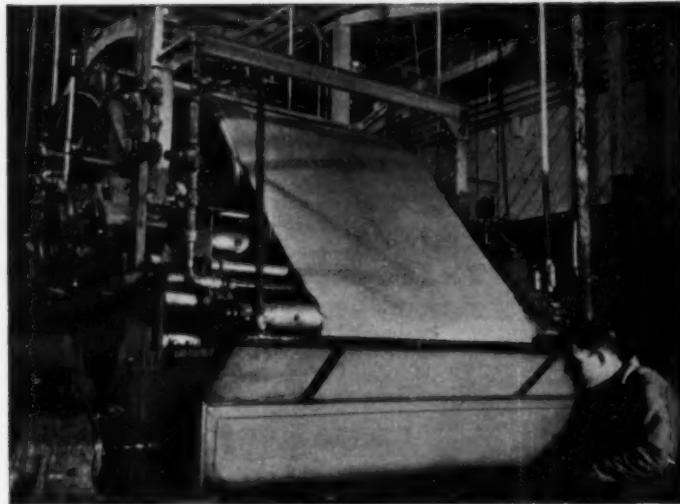
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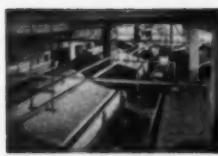




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... *Continuously*

WITH FEinc STRING FILTERS



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A scraper-type filter, handling penicillin broth, was only 85% efficient—over 15% of the available penicillin was left in a wet, sloppy cake.

The manufacturer switched to a FEinc String Filter with a submergence washing mechanism. Better washing removed over 98% of the penicillin from the cake. More complete dewatering left a dry, firm cake, easy to handle for disposal.

In hundreds of cases, FEinc filters have proved their ability to do the job better, faster, and at lower cost. The famous String Discharge handles many "impossible" cakes, continuously filters slurries that would otherwise require batch processes. Special equipment for compression dewatering, cake washing, cake-scoring, drying, and repuddling can be added to the basic filter as required. You'll get a combination that's engineered to do your job best.

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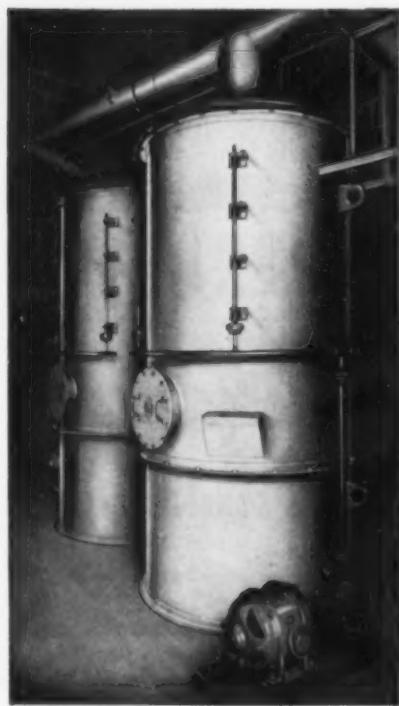
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DUST and FUME Control



MAHON FOG-FILTERS AT WORK

The installation illustrated above was specially designed for the Motor State Oil & Grease Co., Jackson, Mich. **PROBLEM:** To eliminate H₂S odor from sulfonated grease manufacturing operations. The problem was complicated by grease and oil fumes present in H₂S gas. **SOLUTION:** A two-tower Fog-Filter connected in series was designed with high pressure water fog collecting practically all of the grease and oil fumes in the first tower. A caustic solution employed in the second tower and fogged at lower pressure removes the remaining H₂S from the air before it is exhausted into the atmosphere.

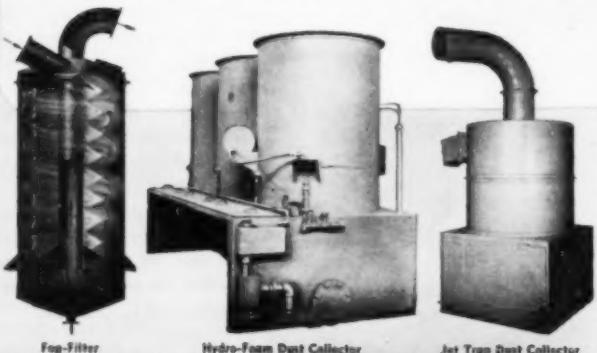
Special equipment engineered to solve individual problems posed by dusts of all kinds, fly ash, chemical fumes, gases of any temperature, aerosols, and other troublesome air pollutants

In dealing with air contaminants, each individual air cleaning problem must be approached with a view to determining what type of collector or filter is required to produce maximum results under existing conditions. Study and analysis of the character and extent of the pollutant is therefore imperative in arriving at a satisfactory solution. Mahon dust and fume control engineers have, over a period of years, developed and perfected special Wet and Dry Collectors and Fog-Filters which have proved highly successful in coping with all types of industrial air contaminants—a few are illustrated here . . . they are serving today in some of the most difficult and mandatory air cleaning jobs in industry. Each installation has been engineered to do the specific job. If you have an air pollution problem, regardless of its character, it will pay you to call in a Mahon engineer and let him show you what Mahon equipment has done with like pollutants under conditions comparable to your own. See Mahon's Insert in Sweet's Mechanical Industries File for further information, or write for Industrial Equipment Catalog A-652.

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Engineers and Manufacturers of Dust and Fume Control Equipment Including Cyclone Collectors, Hydro-Foam Collectors, Jet Trap Collectors, Hydro-Filter Collectors, and Fog-Filters and Cupola Stack Washers.

All Mahon Equipment is Erected by Mahon to Insure Complete Satisfaction.



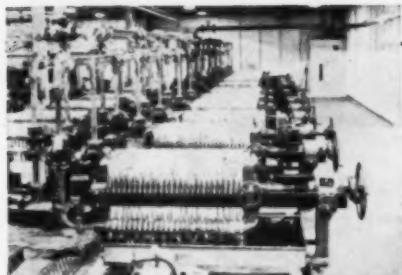
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Hydro-Foam Dust Collector

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or a thousand other products give better filtration at lower cost

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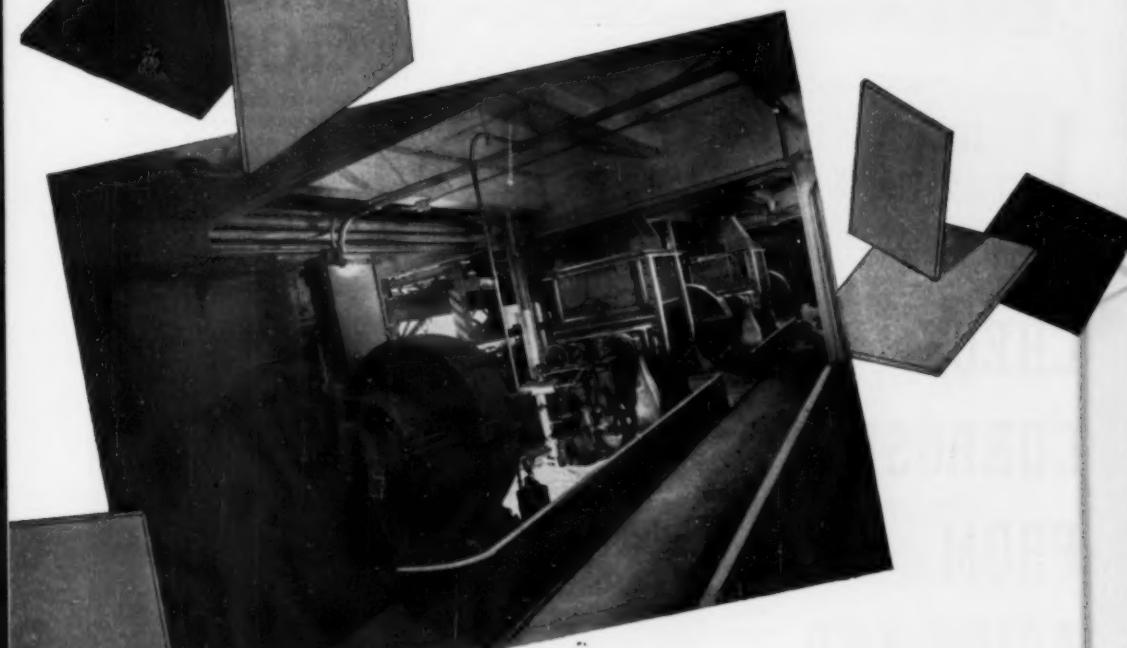
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May 1952—CHEMICAL ENGINEERING

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TO SEWAGE
DISPOSAL PLANTS



CHECK CORROSION FROM ACIDS AND ALKALIES LONGER WITH



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Whatever your power transmission problem it will pay you to talk it over with Philadelphia.



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Shown counterclockwise above—Herringbone, Planetary, Spiral Bevel, Worm Gear Reducers, Speed Increaser, Gear-Motor, Vertical MotoReductor, Steeple Type Worm Reducer.

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J-80263

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"An increasing application of ozone by industry is certain. Resourcefulness and ingenuity are necessary in finding its practical use."¹

1. Murdock, Harold R., Ind. and Eng. Chem., Vol. 43, November, 1951.

Welsbach Ozone Can Help In Solving Your Oxidation Problem . . . *and increase your profits!*

Low-cost, efficient Welsbach Ozone offers industrial users a new tool... a tonnage oxidant at surprisingly low cost—with no full time supervision or labor necessary, with operating costs constant and predictable and maintenance costs negligible!

In installations ranging from chemical processes to treatment of industrial wastes to water purification, it is today's outstanding chemical oxidant.

You can depend on Welsbach Ozone... with a constant flow of all the ozone you want, twenty-four hours a day, day-in and day-out. Add to that these extra dividends: no procurement problems, no materials handling and no storage expense. And no production delays because Welsbach Ozone is generated at the point of use . . . it is always available!

Welsbach's years of ozone research opened the door... industry is finding Welsbach Ozone the answer to its oxidation problems. It could be the answer for you!

Investigate
the potential of . . .

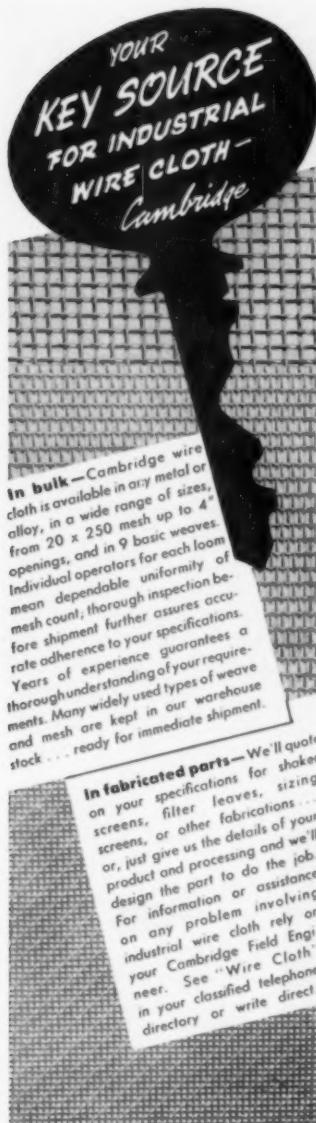
WELSBACK
ZONE

for information, write

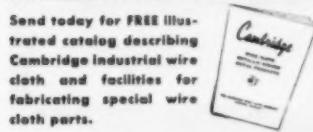
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ZONE PROCESSES DIVISION

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Send today for FREE illustrated catalog describing Cambridge Industrial wire cloth and facilities for fabricating special wire cloth parts.



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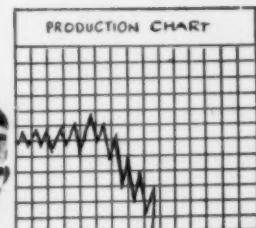
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CHEMICAL ENGINEERING—May 1952

"Quit worrying
about lost production

and do
something!"



install
corrosion
resistant



Right now is the time to act! Take steps toward preventing costly production delays in the future. Specify corrosion-resistant saran lined steel pipe! You'll find, as have many of the country's leading manufacturers, that this remarkable pipe means dependable long term operation at a minimum maintenance cost. Saran's unusual resistance to most chemicals and solvents plays an important part in the reduction of shutdowns and lost production. Another noteworthy advantage is its ease of field fabrication involving NO costly delays with special tools or handling.

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Saran Lined Steel pipe is manufactured by The Dow Chemical Company.

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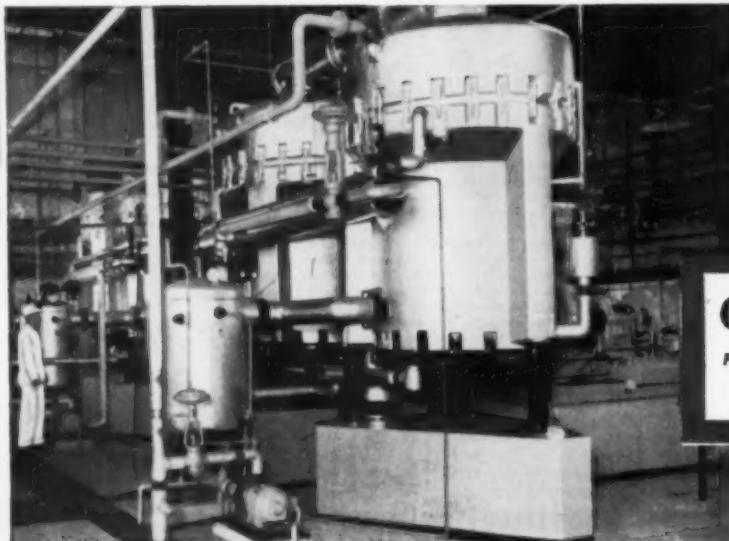
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WHEREVER water is needed — in quantity and quality — a Cleaver-Brooks Compression Still provides the most effective and the most economical method of water purification.

Potable water can be produced using a nearby source of brackish water or sea water, thus eliminating the need for pipe lines, trucking or barging facilities from a remote water source.

Where potable water is already available, but processing requirement demand chemically pure water, a Cleaver-Brooks Compression Still provides a USP chemically pure, pyrogen free water — far exceeding the high standards required for pharmaceutical preparations or chemical processing.

Cleaver-Brooks Compression Stills are available in standard size from 85 gph to 2800 gph motor, engine, or turbine driven.



Cleaver-Brooks Compression Stills at Arrowhead & Puritas Waters, Inc., Los Angeles, Cal. This plant is one of the largest compression still installations in the world, producing over 100,000 gals. of pure water daily.



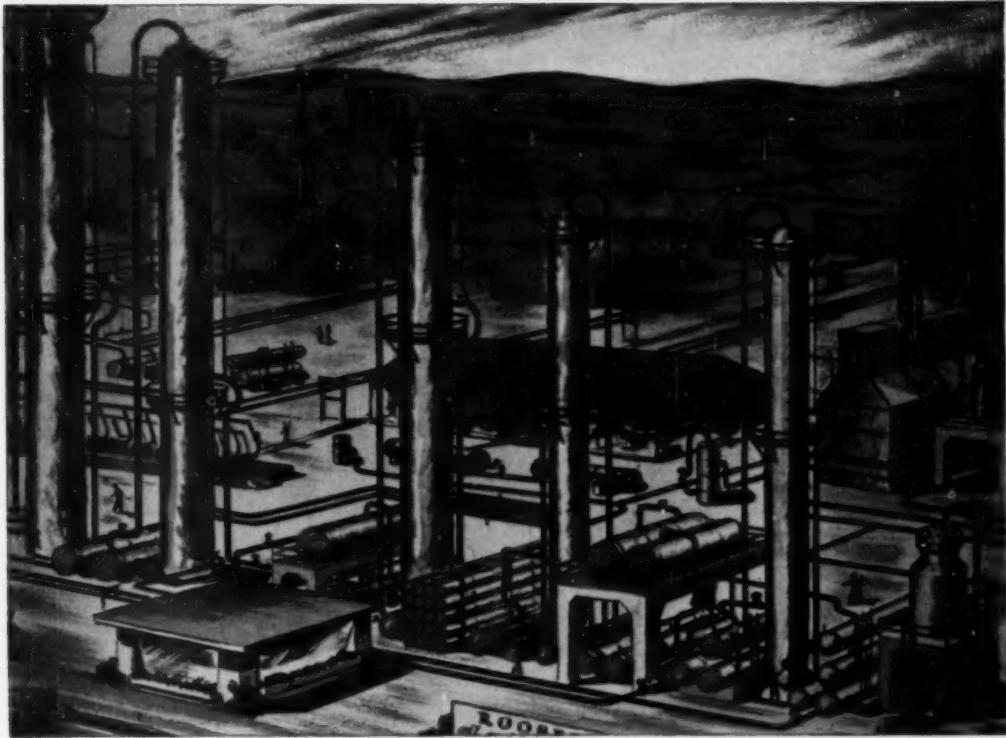
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"Compression Distillation,"
Cleaver-Brooks Company,
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compression distillation

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YOU get the dividends from this \$2,000,000 investment

Here's an artist's sketch of \$2,000,000 worth of equipment that means better products for you. Roosevelt's new platforming equipment is designed to deliver even higher quality solvents and naphthas to you and the hundreds of other manufacturers throughout the Mid-West.

It's another extra dividend you get, as a user of Roosevelt solvents. What are the others? Here are just two: complete catalytic sulphur removal which means non-corrosive, chemically stable solvents, free of offensive odors; and quick delivery to you by truck-transport and tank car quantities from the company geographically located to serve you faster.

Perhaps the aliphatic Naphtha you need is "standard" at Roosevelt . . . if it isn't we'll make it to meet your exact specifications.



Write for your copy of Roosevelt's book of specifications. It's yours for the asking.





Coated Abrasives Division

NOW SERVED BY DAY DUST CONTROL

"Meets our rigid requirements . . .

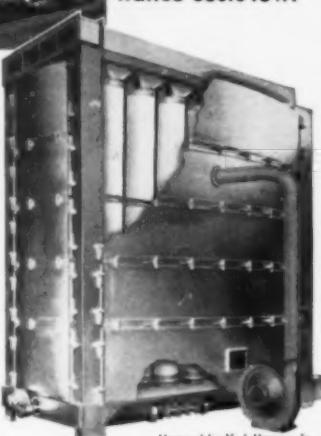
Keeps our plant clean . . .

Keeps our maintenance costs low."

3M Office Building

These are typical statements coming from the Coated Abrasives Division of Minnesota Mining and Manufacturing Co., St. Paul, since the installation of DAY Type "AC" Dust Filters.

Used for the recovery of abrasive materials, the DAY Filters are reclaiming abrasive dusts with better than a 99.998% efficiency. This high filtering efficiency is possible because the principle of operation in a DAY Filter permits the use of a high grade filtering felt. In addition, the other rigid dust control requirements of the 3M Company are being met.



ADVANTAGES OF DAY TYPE "AC" DUST FILTERS

Continuous-Automatic Operation . . . reverse air jet rings move slowly up and down the filtering tubes, cleaning continuously.

Constant Air Volume . . . assured by back pressures leveling off after starting.

Higher Air-To-Cloth Ratio . . . 10, 15,

or even 20 to 1 ratios with uniform back pressures.

Smaller Units, Less Floor Area Required . . . with no sectional shutdowns necessary for cloth cleaning, less filter is required for equal volumes of air.

Separated Dust Streams . . . several different product streams may be handled simultaneously without mixing.

EASY PLANT HOUSEKEEPING: The 3M Company also reports that these advantages make plant housekeeping easy and result in a clean plant—an aid to employee morale, high production and low plant maintenance costs.

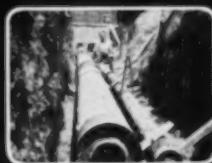
71 YEARS' EXPERIENCE IN INDUSTRIAL DUST CONTROL

The DAY Company is proud to offer skilled engineering and service gained through 71 years' experience in the engineering, manufacture and installation of dust control systems for industry. If you have a dust problem, DAY can provide an effective and economical solution. DAY engineers are at your service for plant studies and cost estimates. CALL OR WRITE TO DAY FOR MORE INFORMATION.



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IN CANADA: P. O. Box 70N, Ft. William, Ontario
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For
**TOP EFFICIENCY
INSULATED
PIPING
SYSTEMS**



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OR



OVERHEAD

Ric-wil
is your
BEST CHOICE

For distribution of steam or hot water, oils or process liquids, Ric-wil Prefabricated Insulated Piping will provide your piping system with maximum sealed-in protection and efficiency.

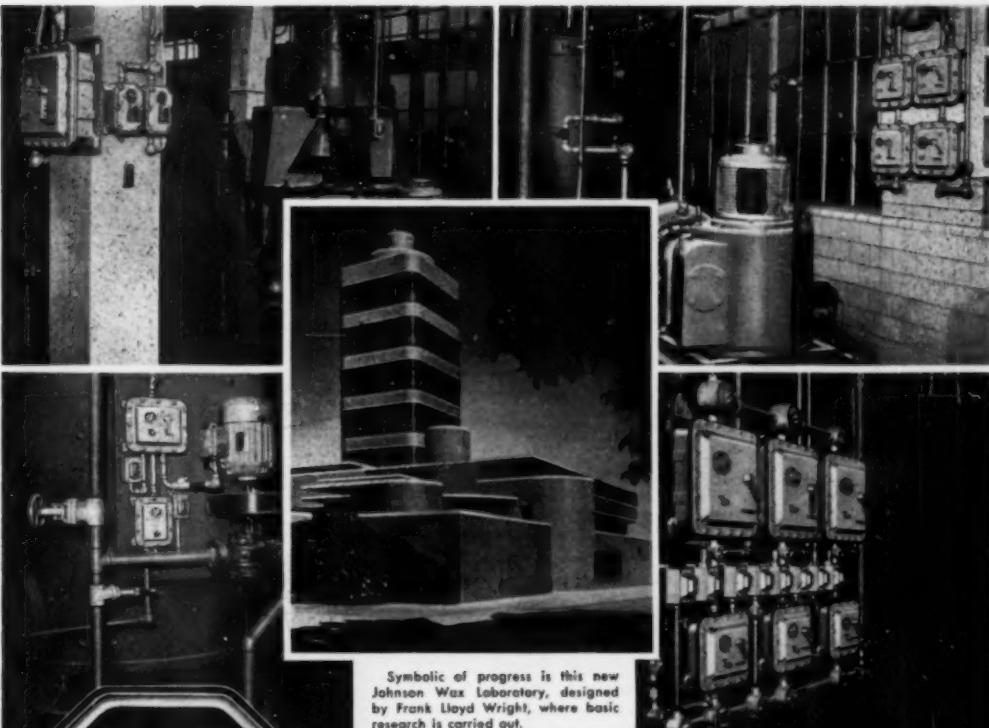
Architects, engineers, and contractors have long recognized the reliability of Ric-wil engineering and manufacturing of high-efficiency insulated piping—factors that insure long trouble-free life of industrial, commercial, and residential piping systems.

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CLEVELAND, OHIO**

Ric-wil

PREFABRICATED
INSULATED PIPING

UNDERGROUND
OR OVERHEAD



Symbolic of progress is this new Johnson Wax Laboratory, designed by Frank Lloyd Wright, where basic research is carried out.

Views show Allen-Bradley motor controls in NEMA Type 7 enclosures, installed in various departments of the production plant, S. C. Johnson & Son, Inc., Racine, Wisconsin.

JOHNSON WAX PLANT equipped with Safe Motor Starters for Explosive Atmospheres

Wherever hazardous gases or vapors exist, Allen-Bradley motor controls in NEMA Type 7 enclosures should be used. Constructed of cast iron with wide machined flanges, these bolted enclosures provide maximum protection.

Allen-Bradley solenoid motor starters and bolted enclosures are an ideal combination, because the double break, silver alloy contacts need no maintenance. These starters have only one moving part—no pins, pivots, bearings, or jumpers to cause trouble. Therefore frequent inspection is unnecessary.

See the nearest Allen-Bradley control engineer, today.

Allen-Bradley Co., 1337 S. First St., Milwaukee 4, Wis.



Bulletin 709 Solenoid Starter in a NEMA Type 7 enclosure.



Bulletin 713 Combination Starter in a NEMA Type 7 enclosure.



Bulletin 609 Manual Starter in a NEMA Type 7 enclosure.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL

QUALITY

GRAVER gives you
ZEOLITE
WATER SOFTENERS
with a choice of

4
DIFFERENT
CONTROLS

Each plant has specific problems requiring individual solution. Typical problems include varying loads, varying water composition, skill of operators, labor and chemical costs, and space availability.

That's why GRAVER zeolite water softener designs include 4 types of controls:

1. **Multiport disc valve, operated manually**
2. **Multiport poppet valve, operated manually and automatically**
3. **Standard gate valves, operated manually**
4. **Individual diaphragm valves, with automatic and manual pilot control**

All components of each type of GRAVER control are *standard available equipment*, of proven operating dependability, ease of adjustment and low maintenance cost, and with readily obtainable replacement parts.

Choice of selection in controls and valves as well as other components is a feature of all GRAVER Zeolite Softener installations. GRAVER Zeolite equipment includes sodium and hydrogen zeolite softeners, hot zeolite after-treatment, and demineralizers; and GRAVER Zeolites include all the modern highly effective synthetic resins of proven performance, checked by experts in the field of ion exchange. Write for recommendations and complete information on your particular needs and request your free copy of the technical paper "Present Practices in the Use of Ion Exchangers."

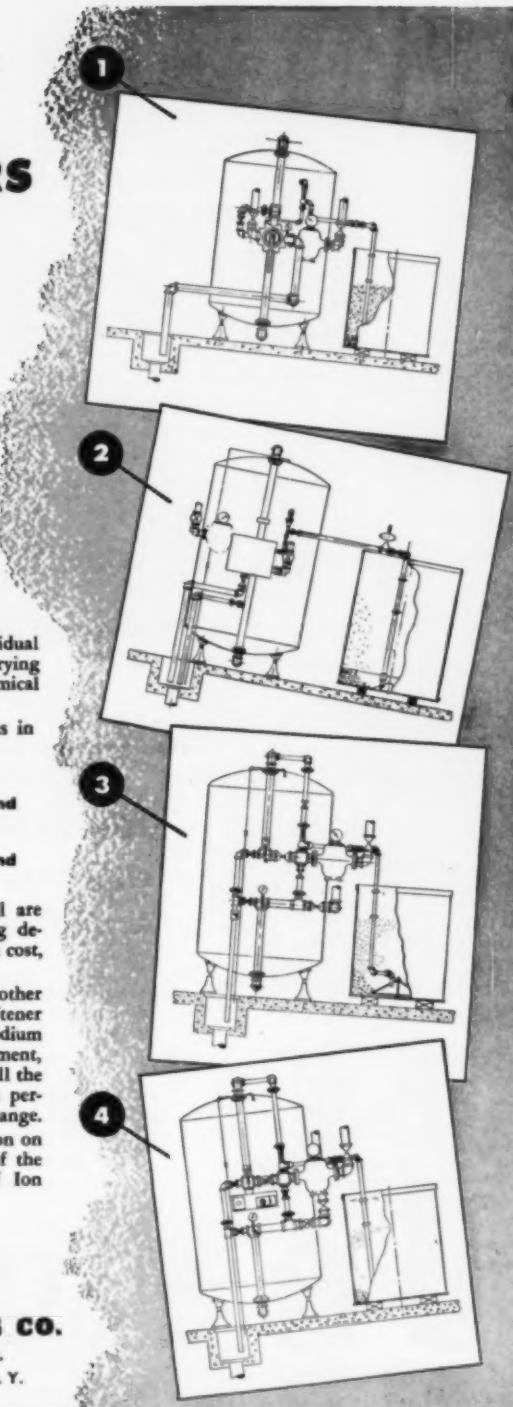


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Division of Graver Tank & Mfg. Co., Inc.

Dept. CE-Z, 216 WEST 14th STREET, NEW YORK 11, N.Y.

Manufacturers of Equipment for ALL Water Conditioning Processes



Fastenings by HARPER of all non-corrosive metals



Fastenings of brass—Naval bronze—silicon bronze. Fastenings of Monel—nickel—all stainless steels—aluminum. Any type of fastening—bolts—nuts—screws—rivets—studs—washers—cotter pins. The H. M. Harper Company produces them all—one source of supply—the largest manufacturer specializing in production of fastenings of non-corrosive metals.

Back of this company are 29 years of experience in meeting and solving tough problems of corrosion and abrasion, heat and stress. No order is too small for the most careful attention of Harper engineers and metallurgists. No order is too large for the modern Harper plant to handle.

In every important market area in the country there is a Harper distributor with stocks of fastenings, ready to give you immediate service. If you have a tough problem that can be solved by fastenings of non-ferrous metal or stainless steel, the Harper years of experience and ability can help you. Call your Harper salesman or write to the Harper engineer.

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8206 Lehigh Ave., Morton Grove, Ill.

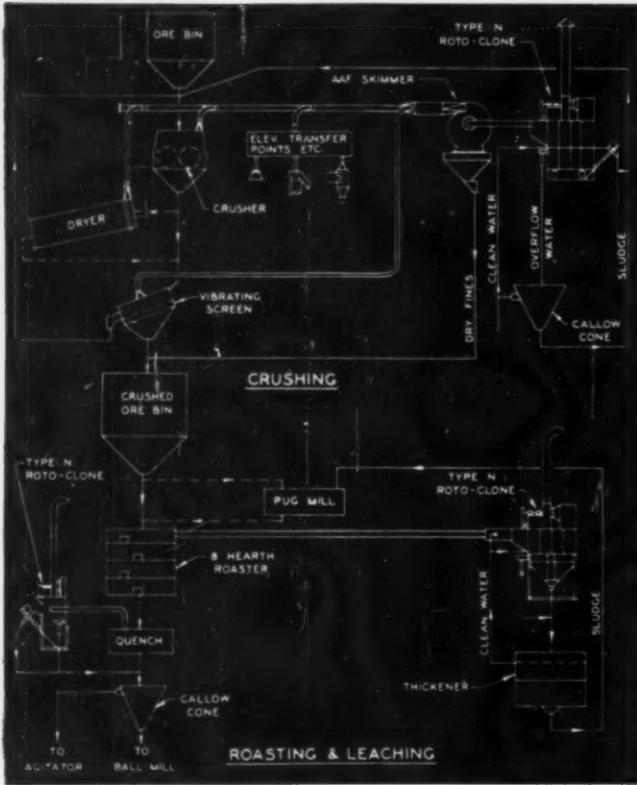
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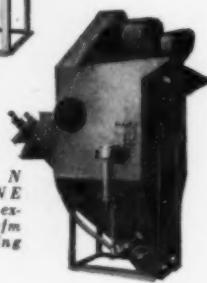
for uranium beneficiation



Type N ROTO-
CLONE Arrange-
ment C with
automatic sludge
ejector, exhausting
dryer, crusher
and vibrating
screen.



No. 16 Type N ROTO-
CLONE Arrangement
D continuous slicing
of sludge exhausting
roaster.



ROTO-CLONE DUST CONTROL

ROTO-CLONE Engineered Dust Control adapted to new milling process increases efficiency and uranium production.

In reactivating a large uranium mill, a new process was developed for continuous leaching of carnotite ores to replace an inefficient batch leaching technique. However, dust was a problem. Excessive amounts could not be

tolerated, if several operations in the cycle were to maintain highest efficiency. This was particularly true of the roaster feed. Also, samples of fine dust showed it carried 4 to 7 times more uranium values than the run of ore.

ROTO-CLONE engineered dust control proved the efficient solution to both problems. It eliminated dust produced by critical operations, and

also permitted recovery of the high value fines. In this application the salvage value of the collected material was an extra dividend.

The many types, sizes and arrangements of ROTO-CLONE provide practical answers for most dust control problems. Write us today for Engineering Bulletin No. 277 which contains essential information and application data.



American Air Filter

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American Air Filter of Canada, Ltd., Montreal, P.Q. • Pacific Division Office, San Francisco, California



handles Boiling HCl for 2½ years!

This HASTELLOY Alloy Condenser
is still on the job
in 1-10% Acid Solution

This condenser, made of HASTELLOY alloy B, shows no signs of corrosion after two and one-half years in a vacuum still for the distillation of hydrochloric acid. Since it was installed, the unit has been in operation two to three days a week, eight hours a day, handling a dilute solution of the corrosive acid at temperatures up to the boiling point.

HASTELLOY alloy B is one of the few commercially available materials that can handle boiling hydrochloric acid—one of the most severely corrosive agents known to the chemical industry. Alloy B is available in all standard wrought forms and can be fabricated by most common methods. Two additional HASTELLOY alloys, designated as C and D, are also available for handling other highly corrosive chemicals, such as sulphuric acid and certain strong oxidizing agents, like ferric chloride and wet chlorine.



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alloys

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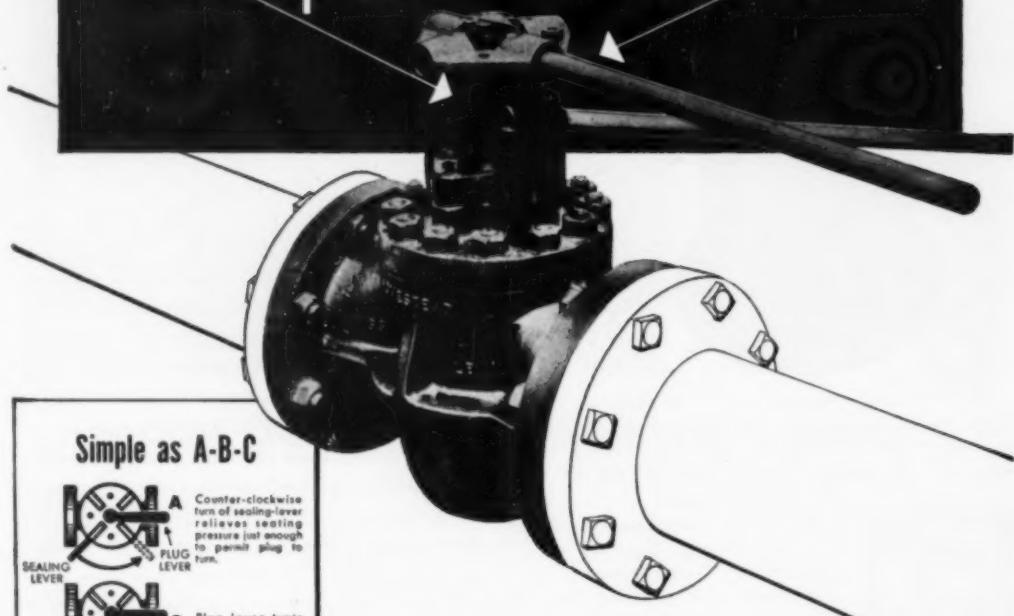
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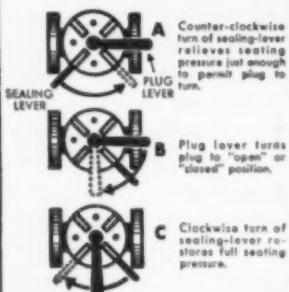
- at all times
- under all conditions
- throughout its long lifetime of service

This Homestead Valve will always work

it's **stickproof** because it's **lever-sealed**



Simple as A-B-C



Homestead Lever-Sealed Valves operate faster, too—16 to 28 times faster than screw-stem type valves. They require no lubrication . . . provide unobstructed, straight-line fluid flow with minimum pressure drop . . . afford maximum protection to sealing surfaces against corrosive and erosive line fluids. And because only a quarter-turn is needed for full opening or closing, they are ideal for installation in restricted areas where operation of other types of valves might be difficult.

Next time you have damaged or sticking valves, replace them with Homestead Lever-Sealed Plug Valves. Once you use them you'll never be satisfied with ordinary valves.

For complete information write for Valve Reference Book No. 39-3.

HOMESTEAD LEVER-SEALD PLUG VALVES

HOMESTEAD VALVE MANUFACTURING COMPANY

P. O. Box 13

Serving since 1892

Cressona, Pa.

FOR THOSE EXTREMELY CORROSIVE CONDITIONS . . .
CONSIDER THE USE OF *Amer-Plate*



**Available in Two Convenient
Types To Meet Your Needs**

**Plain AMER-PLATE for existing steel
or concrete tanks or structures**

Plain Amer-Plate is smooth and flat on both sides. It is applied to existing surfaces using specially developed cements that provide a firm bond with those surfaces.



**T-LOCK AMER-PLATE
for newly cast
concrete pipe
and structures**

T-shaped parallel "anchors" are an integral part and extend along the back of each Amer-Plate sheet. The sheet is applied to the inner forms of tanks, concrete pipe, and structures. When the concrete is poured, the tees are embedded and locked into the concrete.



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INDUSTRIAL SHEET LINING**

Especially designed to protect against extremely corrosive conditions, Amer-Plate is particularly adaptable for use in highly corrosive sewers, chemical storage tanks, tank cars and tank trucks hauling unusually corrosive solutions.

Composed of inert resins and plasticizers, Amer-Plate is impervious to gases, highly resistant to acids, alkalies, alcohol, oils, salts, and petroleum products. It has a very low moisture vapor transmission rate, will not support combustion, and contains no toxic materials.

Amer-Plate is a flexible thermoplastic sheet, practical for application to flat, curved and angular surfaces. Its economy and effectiveness has been proved in the field in over 10 years of development and testing.

So... wherever you require long lasting protection against extreme corrosion, make a full investigation of the possibility of using Amer-Plate. Write for complete information.

Amer-Plate industrial sheet lining is the result of many years experience in the manufacture and application of Amercoat protective coatings.

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The True Yardstick of Air Hose Value

When buying air hose, your thinking should not be in terms of footage-per-dollar but rather in terms of service hours.

Experience tells you that the hose which is built with an *extra* measure of strength, flexibility, damage resistance and safety is surely your soundest investment.

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Warehouse Stock, 711 N. Canal St., Chicago, Ill.



CONCORD AIR — An extra quality, exceptionally rugged hose for toughest use on air drill and pneumatic service in mines, quarries and construction jobs. Non-porous tube resists heat and oil. High tensile cotton yarn braid reinforced carcass. Tough grey cover resists cutting, gouging, abrasion. 7 sizes from $\frac{1}{2}$ " 2-braid through 2" 3-braid. 200 to 300 lbs. working pressure. Maximum length 50'.



BAY STATE AIR DRILL — For heavy construction work in mines, quarries, tunnels and wherever large size hose is required for long service. Smooth black tube resists heat and oil. Carcass of strong, rubber-impregnated multiple ply woven duck. Rugged, heavy-gauge red rubber cover resists severe weather extremes, cutting, abrasion. 9 sizes stocked from $\frac{1}{2}$ " to 4". Working pressures from 150 to 225 lbs. Max. length 50'.



AUROCHS AIR — For portable air compressors, jack-hammers, rugged industrial and construction work. Smooth, black, non-porous tube resists heat and oil. Carcass: multiple ply, rubber-impregnated, rugged woven fabric. Tough black cover resists weather and abrasion. Stocked sizes: $\frac{1}{2}$ ", $\frac{3}{4}$ ", 1". 200 lbs. working pressure. Maximum length 50'.



VIM AIR — For general industrial use, on compressors and pneumatic tools. Black tube resists oil and heat. Husky cotton yarn braids. Smooth, red cover resists weather, abrasion. 8 sizes stocked, $\frac{1}{4}$ " 2-braid to 1" 3-braid. Working pressures: 150 to 225 lbs. Maximum length 50'.



BULL DOG VARI-PURPOSE AIR — For a variety of jobs including handling of air, water, oil, gasoline, kerosene (not for paints, lacquers, lacquer-solvents). Black, synthetic tube resists oil and heat. Carcass is braided rayon cord, high strength, super flexible. Smooth, brown, tough synthetic cover resists oil, abrasion, sunlight. 11 sizes stocked from $\frac{3}{16}$ " one-braid to 1" 2-braid. Working pressures: 200 to 300 lbs. Maximum length approximately 500'.

Hooker Chemical Guide (ONE OF A SERIES)

USE this handy reference to save time
in selecting high quality chemicals.

HOOKER SULFIDES

SODIUM SULFIDE

Formula: Na_2S

Appearance: Light, buff colored solid
in flake form

TYPICAL PROPERTIES

Molecular Weight	78.1
Melting Point	100° C
Na_2S	60-62%
Water of Crystallization	35% min.
NaCl	1.5% max.
Other Na Salts	2.0% max.
Fe	8 ppm max.
Other Heavy Metals	1 ppm max.

SODIUM SULPHYDRATE

Synonym: Sodium Hydrosulfide

Formula: NaHS

Appearance: Light lemon colored solid
in flake form

TYPICAL PROPERTIES

Molecular Weight	56.1
Melting Point	55° C
NaHS	70 to 72%
Water of Crystallization	26% min.
Na_2S	2.5% max.
Other Na Salts	1.2% max.
Fe	5 ppm max.
Other Heavy Metals	1 ppm max.

SODIUM TETRASULFIDE SOLUTION

Formula: Na_2S_4

Appearance: Clear, dark red aqueous
solution

TYPICAL PROPERTIES

Molecular Weight	174.2
Freezing Range	3.5° to -17° C
Distillation Range	115° to 120° C
Specific Gravity, 15.5°/15.5° C	1.335
Na_2S_4	40%
Sulfur	30%

For detailed information on items listed, drop us a note on your letterhead. Address your request to HOOKER ELECTROCHEMICAL COMPANY, 5 Forty-Seventh Street, Niagara Falls, N. Y.

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Dehairing Agent: Hides

Desulfurizing Agent: Viscose rayon

Intermediate: Chemicals, dyestuff intermediates

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USES

Dehairing Agent: Hides

Desulfurizing Agent: Viscose rayon

Intermediates: Dyestuffs; organic chemicals such as thioamides, thiourea, thioglycolic acid, thio- and dihydrobenzoic acids, sodium thiosulfate.

USES

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Reducing Agent: For organic nitro bodies

Reagent: Ore flotation

Intermediate: Sulfur dyes

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CHEMICALS

® 2-325



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can't get out!*

WHEN YOU USE CHASE® COPPER WATER TUBE

For refrigeration lines, you can't beat the combination of Chase Copper Water Tube and Chase Solder-Joint Fittings. They form pressure-tight and leak-proof soldered connections. Chase Wrought Copper Fittings are non-porous . . . even Freon can't get through.

FOR MANY OTHER INDUSTRIAL USES, TOO, you'll prefer Chase Copper Water Tube. It's corrosion-resistant, and will not clog with rust. Its smooth interior permits an easy flow of bulky industrial fluids with lower pumping pressures.

To avoid costly repair and replacement jobs on process lines, investigate Chase Copper Water Tube.

Chase  BRASS & COPPER

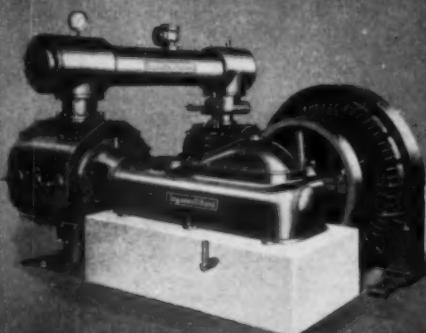
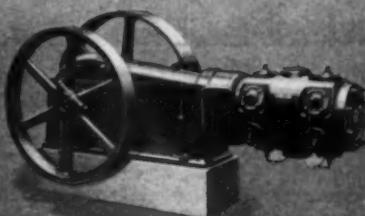
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* The Nation's Headquarters for Brass & Copper

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		New Orleans		

Oil Free Air for your Instruments

**INGERSOLL-RAND HAS NL COMPRESSORS
FROM THE SMALLEST
TO THE LARGEST**



Air-operated instruments, like production tools, are vitally important. That's why so many plants are using Ingersoll-Rand NL air compressors, that *don't pump oil*. This guards against instrument failures caused by oil-laden air.

Non-lubricated compressors, pioneered by I-R, feature pistons fitted with graphitic-carbon rings that prevent metallic contact of the piston with the cylinder bore. These carbon rings are segmental with metallic inner expanding rings, to give the proper wall pressure. Because metallic contact is eliminated, and the rings are self-lubricating, the Ingersoll-Rand NL Compressor cylinders require no lubricant.

To really put an end to production delays and excessive maintenance costs caused by oil-clogged instruments, get all the engineering facts and figures I-R makes available. Simply contact your nearest I-R representative, or write direct to Ingersoll-Rand, 11 Broadway, New York 4, New York.

Model N machines available through 1 hp.

Model 235 HNL machines available through 3 hp—
other models through 250 hp.

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717-3
Compressors . . . 70 years of compressor "know-how"
packed into these new compressors
for air operated instruments!

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

How to add months
... even years to
equipment life!



This Super Stainless Gives You New Freedom From Corrosion!

When you're faced with a severe corrosion problem, investigate the super corrosion resistance of Carpenter Stainless No. 20. This sulphuric acid resisting Stainless can often reduce shutdown time and add substantially to equipment life.

If you are familiar with this alloy in its cast form, known as Durimet 20*, you can appreciate Carpenter No. 20's superior resistance to sulphuric acids, plating and pickling solutions, mixed acids, etc. Now that Carpenter has solved the problem of producing this Stainless in rolled forms such as bars, wire, strip and tubing, the alloy is enabling industry to add months—even years to equipment life.

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The Carpenter Steel Company • 127 W. Bern St. • Reading, Pa.
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industrial magazines and through technical society journals. Do not stop reading such periodicals; but be sure to add THE essential one

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Protecting product purity with MONEL

Is corrosion putting the bite on your equipment?

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Producing highly refined salt for the food processing industry, they needed a special material for new brine evaporating pan hoods.

They needed a material that was highly resistant to corrosion...because...corrosive salt vapors condensing on a non-resistant hood would carry heavy metal impurities back into the slurry, thus contaminating the salt.

And they needed a material that had special fabrication features. It had to have the same high corrosion resistance in weld areas as in the sheet itself.

These requirements, plus their experience with Monel® in heat exchangers, dryers, and conveyors, led them to select Monel again.

They now have four hood assemblies in use, giving excellent service in the production of a high quality salt...thanks to Monel.

* * *

So, if you are bothered by corrosion or have difficulty maintaining purity of product, perhaps Monel offers you a solution, too. Consult our technical staff. They will be glad to help you. Just write giving full details.

Remember, however, that because Nickel and Nickel Alloys like Monel are on extended delivery, it will pay you to anticipate your needs. Order well in advance giving necessary NPA rating and complete end-use information.

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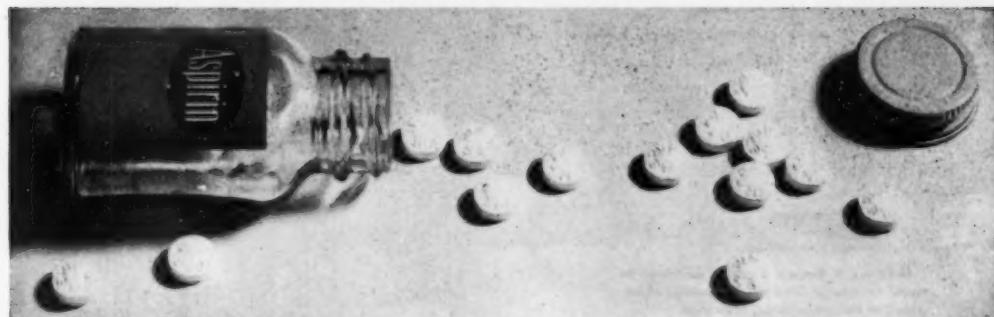
For more information about Johns-Manville Goetze Gaskets, write for your copy of Catalog PK-35A. Or send us your drawing or template for an immediate quotation. Address: Johns-Manville, Box 60, New York 16, N. Y.



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You can't stop corrosion
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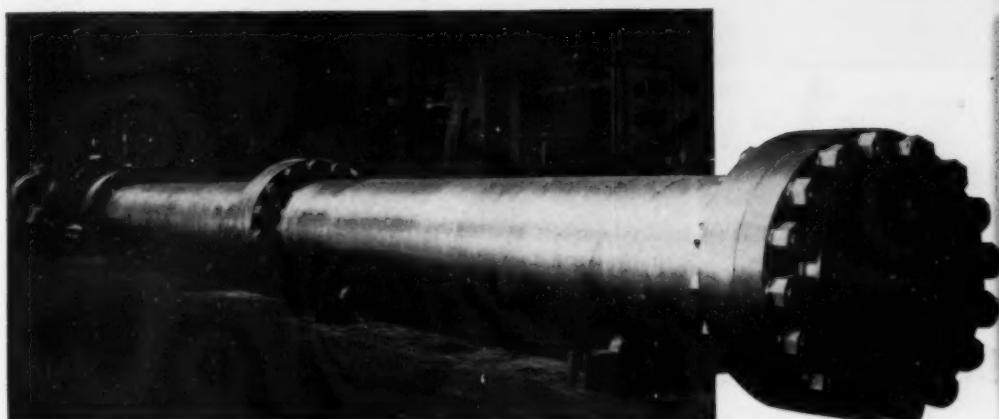
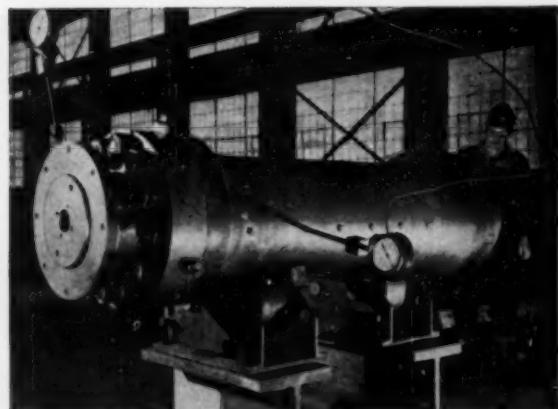
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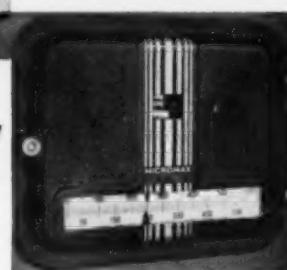


Dependable "ON-OFF" Controllers for Industry

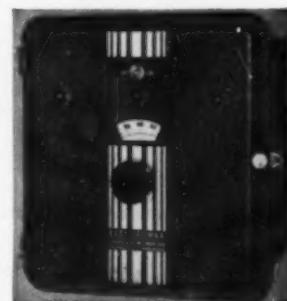
THE kind of control instrument which industry calls on-off or 2-position is not only the oldest form of automatic regulator, but is one which many manufacturers still use, instead of more advanced types, for simple requirements. Usually, the instrument merely closes the valve when temperature reaches the control point, and opens valve again when temperature falls below point. The question of whether such on-off action is best for the given case can of course be settled by using the instrument with the best, most useful features. Here are some which L&N On-Off Controllers offer:

1. Instruments may be Recording Controllers with either strip-chart or round-chart, or Controllers with no charts at all.
2. Instruments can operate at high or moderate speed; can be located regardless of machine vibration, building tremors or distance from process.
3. Controls are outstandingly dependable because they "balance" temperature against a standard. Intermediate bearings and springs cannot increase, decrease or otherwise influence accuracy or sensitivity.
4. Low maintenance assured by machine-like design and construction.
5. More than 1000 standard ranges. Specials are available, but seldom needed.

Tell us your problem and we will send further information. Write either to our nearest office or to 4916 Stenton Avenue, Philadelphia 44, Pa.



MICROMAX MODEL C ON-OFF CONTROLLER



ELECTRONAX ON-OFF CONTROLLER

THESE instruments are fully automatic; need no standardizing; are ideal even for hard-to-get-at or difficult locations.



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especially for Performance and Economy

N-propyl acetate is the first in a series of esters to be produced by Celanese. It is a medium boiling, low viscosity solvent with a pleasant odor and excellent blush resistance. An economical replacement for such solvents as MIBK, butyl acetate-ethyl acetate combinations, and secondary butyl acetate, Celanese* n-propyl acetate is now available in 90%-92% concentration—in volume quantities to meet both large and small scale requirements.

With the addition of n-propyl acetate, Celanese can now offer a diversified line of organic solvents, providing formulators with the flexibility and economy of split shipments in compartmented tank trucks and cars at bulk prices.

Investigate the cost-saving possibilities of n-propyl acetate. A Celanese technical representative will be glad to review your formulations, and demonstrate how Celanese solvents

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Properties

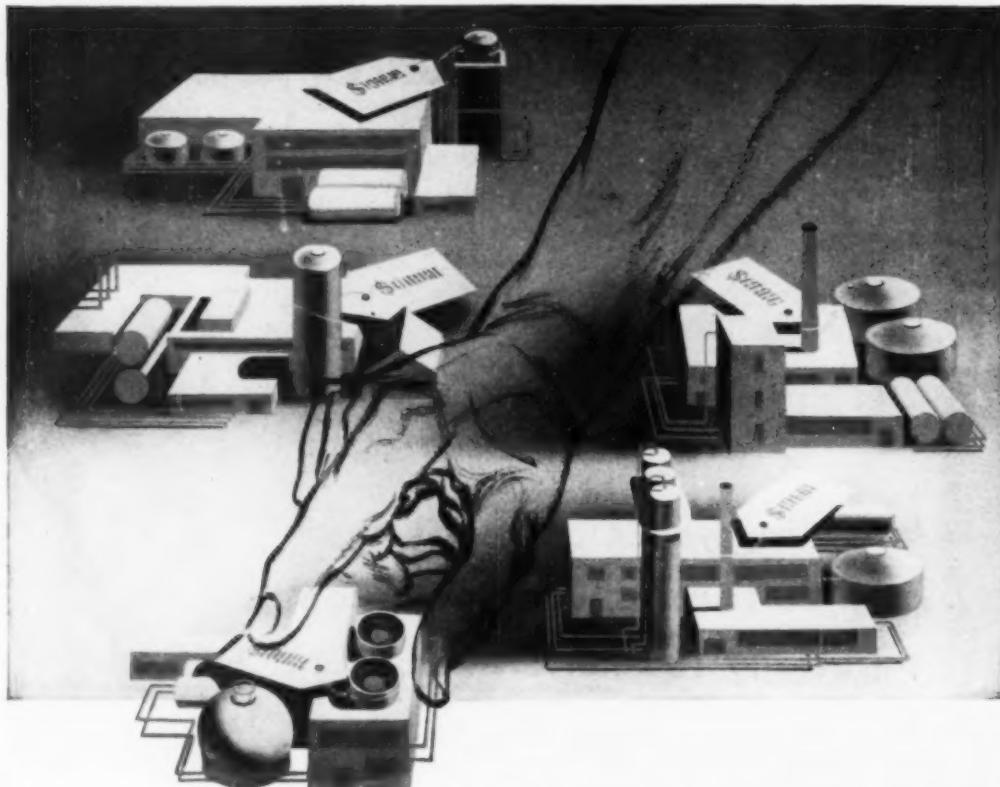
Color 15 APHA
Spec. Grav. 0.880—0.885 @ 20/20°C
Boil. Pt. 95°C—103°C
Ester Content . . . 90%—92%

Solvents by Celanese

Solvent 203	Acetone
Solvent 301	Methanol
Solvent 601	n-Propyl Acetate
Solvent 901	Butyl Alcohols



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How to Shop For Extra Productivity

If you feel the output of your plant could be increased, you may be interested in what a company we know did. Their *process* probably differs from yours. But the way the problem was approached applies.

This company wanted economical drying of sodium chloride from a moisture content of 5% down to .01%. Protection of product purity was a must. The answer, in their case, was 3 continuous-flow, rotary-type driers of nickel-clad steel with solid nickel baffles. The driers are internally heated to 320° C. by four burners using natural gas. Ring gears rotating the drums are spring-mounted to relieve load and wear on teeth. Nickel working surfaces and parts protect the product from metallic contamination, and the equipment from corrosion and abrasion.

Rapid, economical drying resulted—

60 tons of salt per drier per 22-hour day. Seeing this performance, this company ordered a battery of 3 more driers to bring its total to six.

Can more dollars be squeezed out of your throughputs? This company did it through combined planning by the engineering staffs of progressive Equipment Builders, process engineers, designers and materials suppliers. Such builders turn to Lukens regularly for its knowledge of materials and its wide range of low-cost clad steels.

Even with new equipment hard to get, these builders can often recondition what you have for better, more profitable use. Would you like their names? Write us today explaining your need. Manager, Marketing Service, 400 Lukens Bldg., Coatesville, Pa.



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HOW THIS RUBBER LINED VALVE
stretches dollars
IN CORROSIVE SERVICES!

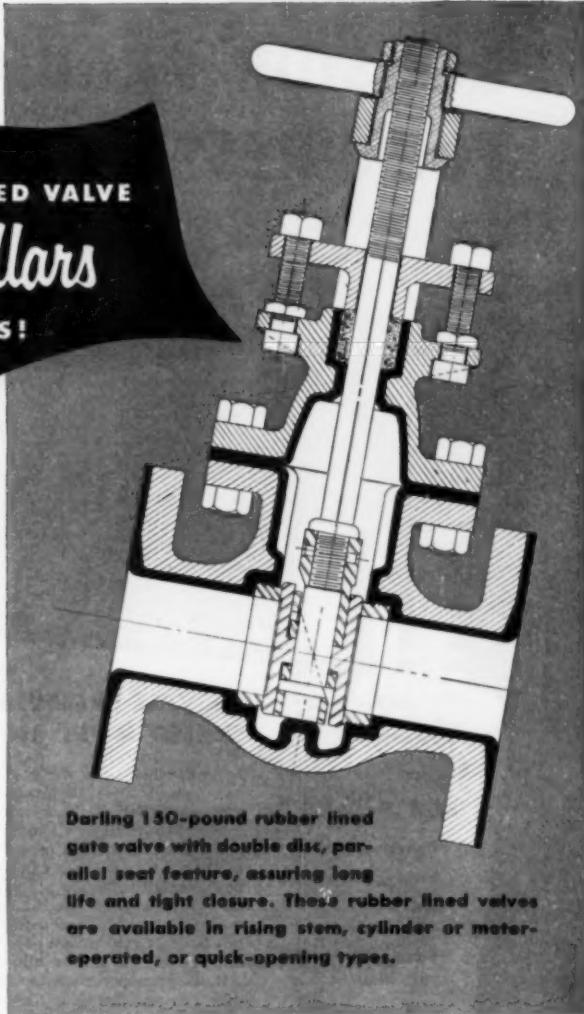


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DARLING
fully revolving double disc
iron body gate valve

IN many corrosive services up to 180° F., Darling hard rubber lined iron body gate valves are taking the place of costly special alloy valves . . . saving plenty of dollars!

And when it comes to year-in, year-out behavior, they can't be beat! A proved bonding technique permanently prevents separation of the hard rubber lining from the valve body. All interior working parts are made of alloys suitable for the corrosive conditions involved.

Equally important, these valves feature Darling's fully revolving double disc parallel seat principle. This, combined with the equalizing wedges, means easy, tight closure even if seats are not parallel due to line stresses. It means uniform distribution of wear for prolonged life with minimum maintenance cost.



Darling 150-pound rubber lined gate valve with double disc, parallel seat feature, assuring long life and tight closure. These rubber lined valves are available in rising stem, cylinder or motor-operated, or quick-opening types.

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DARLING VALVE & MANUFACTURING CO.

Williamsport 3, Pa.

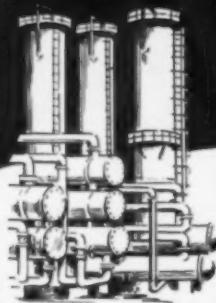
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CHEMICAL ENGINEERING—May 1952



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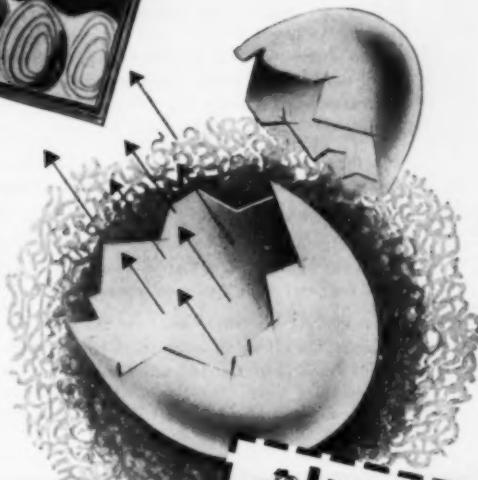
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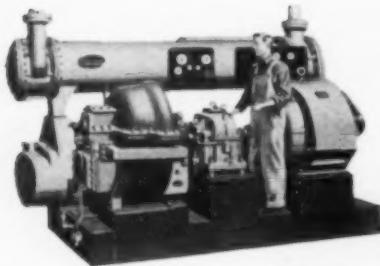
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And *Carrier servicemen*, part of the largest, most experienced national service organization in the industry, insure the reliability that's been engineered and built into each Carrier Centrifugal. Seldom called, these experts are at your service on a moment's notice.

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The same reliability is yours in a Carrier Absorption Refrigerating Machine (left) which produces refrigeration from high-pressure or low-pressure steam or waste steam from other plant equipment; and in the packaged

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...doing exceptionally
well on two
difficult
filtration jobs



The jobs are difficult because the cakes are thin and sticky and almost impossible to discharge from a standard wire-wound drum type filter.

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The Oliver Panel Filter is handling its job effectively because of its special discharge cross-wires set at the proper angles and tension. These wires lift the cake off 'clean as a whistle.' On the Panel Filter there is no wire winding to hold the cover in place. It's placed over two or three panels and calked into grooves. Flow rates stay high.

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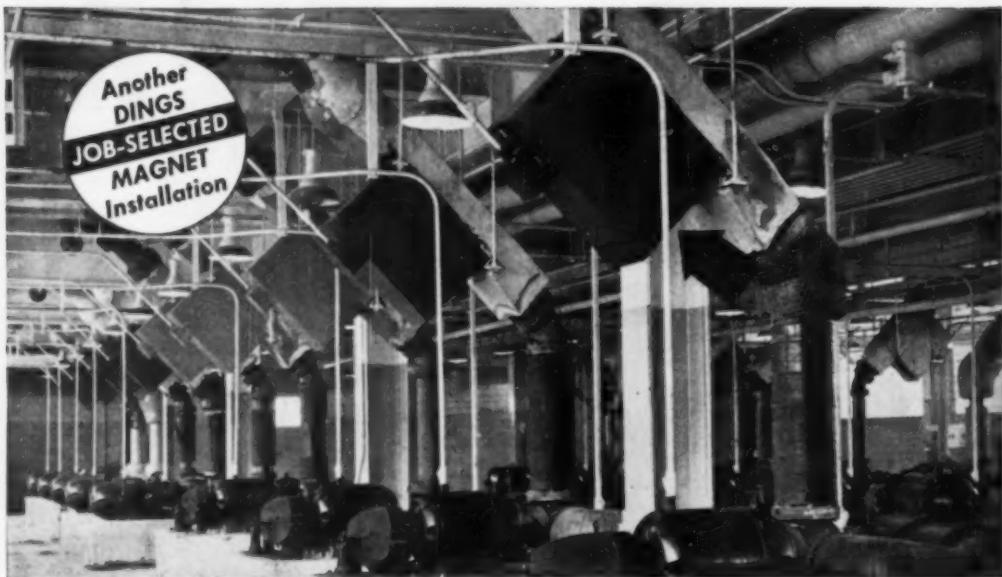
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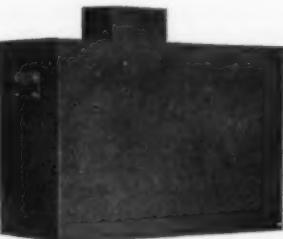
E. L. Bateman Pty., Ltd.
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Threat to \$33,000 Removed by Dings Magnets

Acetate Plant Gets Surprise;

Unloads 20 lbs. of Iron



A chemical pump has no palate for iron—a single nut or bolt can wreck it. When a large acetate plant installed 30 Dings watertight rectangular electro-magnets—one ahead of each pump—they were protection conscious—said they'd be surprised and satisfied if the whole battery found one or two bolts total. In 4 months, the Dings Magnets extracted over 20 lbs. of tramp iron . . . enough to wreck all thirty pumps . . . \$33,000 worth!

This plant achieved its objective to a degree beyond expectations. Three factors were responsible: (1) applying exactly the right magnet for the job; (2) the magnet itself was highly engineered and quality built; and (3) the magnet was correctly installed. Whatever your tramp iron problem, those are the things you buy when you buy a Dings "Job Selected" Magnet. Investigate today.

Dings Magnetic Separator Company

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*World's Largest Exclusive Builder
of Magnetic Separators*

THIS IS THE TYPE THAT DID THE JOB. *The magnet that fit this job best is a Dings Rectangular (electro), a particularly versatile magnet which is effective at distances up to 18". Its triple pole design makes it effective on the most difficult jobs; fast moving conveyor belts, wet, sticky material, etc. Can be adapted in any number of ways to suit particular requirements. Catalog 301-A gives details.*

This Catalog Helps You to "Job Select" a Magnet
Is the material you want de-ironed solid . . . semi-solid . . . liquid? Is it carried in chutes . . . ducts . . . conveyor belts? Catalog 5000-B lists Dings complete line by application, describes all Dings magnets from the low cost, non-electric "Perma" Plate magnet to the most powerful magnetic separators known. Send for it today.

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Non-Electric and Electric Poleless



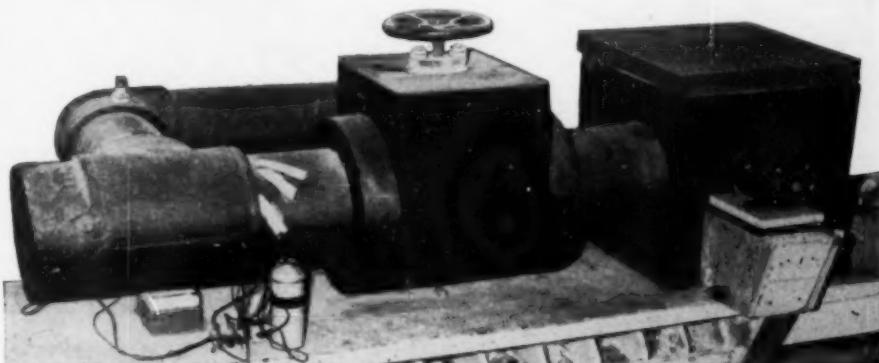
Non-Electric Drums



High Intensity Type EBK Crossbelt



ON THIS APPARATUS, 3" FOAMGLAS Pipe Covering was tested for a period of one year, cycling between minus 100° and plus 350° F. The test was designed to accelerate any deterioration that might occur under actual field conditions. A total of 52 cycles was completed, with no loss of insulating efficiency.



---THIS DUAL-TEMPERATURE TEST PROVED "No loss of insulating efficiency"

● Its ability to withstand both extremely low and high temperatures—over long periods of time—has won wide preference for FOAMGLAS among chemical engineers for their low and dual-temperature requirements. It is being used successfully on piping, valves and fittings, heat exchangers, towers, tanks, boilers and other process equipment.

The constant insulating efficiency and durability of FOAMGLAS are due to its cellular glass construction which resists moisture and other harmful elements. FOAMGLAS doesn't get soggy, slip out of place, rot or shrink, as do ordinary materials which constantly need costly maintenance and finally have to be replaced.

Get the latest information on FOAMGLAS whenever you need insulation. Just send the coupon for a sample of the material and a copy of our authoritative booklet.

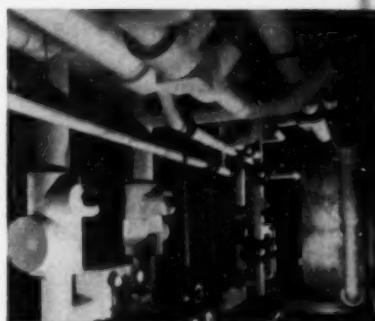
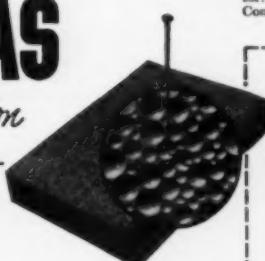
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The best glass insulation is cellular glass. The only cellular glass insulation is FOAMGLAS. This unique material is composed of still air, sealed in minute glass cells. It is light weight, incombustible, verminproof. It has unusually high resistance to moisture, chemicals and many other elements that cause insulation to deteriorate.



FOAMGLAS insulates these dual-temperature lines. A canvas and paint finish completes the application. General Contractor: Beers Construction Company, Atlanta, Ga. Insulation Contractor: North Brothers, Atlanta, Ga.

Pittsburgh Corning Corporation
Dept. CC-52, 307 Fourth Avenue, Pittsburgh 22, Pa.

Please send me, without obligation, a sample of FOAMGLAS and your FREE booklet on the use of FOAMGLAS for Piping and Process Equipment.

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Address.....

City..... State.....

PENBERTHY Liquid Level Gages



**YOU CAN Remove
and Replace
Without Shutdown**

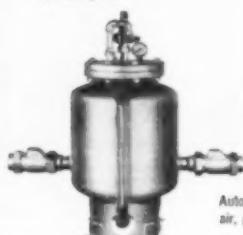
Union connections between the gage and the valves permit removal of gage for repairs without shutting down the equipment. Just close the valves, uncouple the unions and remove the gage. The convenience of this is obvious. When glasses have to be replaced or repairs made, it is not necessary to work in an awkward position or to shut down. Another advantage: a gage needing repairs can be replaced immediately by a spare and the repairs made at leisure. There are many other reasons for the superiority of Penberthy Liquid Level Gages; ask for Catalog 35.

OTHER PENBERTHY PRODUCTS



PENBERTHY TRANSPARENT GAGE

Used to observe color and density of liquids under high pressures and/or temperatures. Exceptionally sturdy construction—liquid chamber machined from solid block of metal. Ask for Catalog 35.



PENBERTHY CYCLING JET PUMPS

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4672

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- low original cost
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Here is one of a number of compact Foote Bros. Line-O-Power Drives installed in the Ford Motor Company Dearborn Specialty Foundry Rouge Plant. These drives are transmitting power to the bucket conveyors that raise sand to the hoppers.

Heavy loads, continuous service, dust conditions, all try the stamina of enclosed gear drives in applications such as this. Line-O-Power Drives have proved their ability to stand up, even under such tough conditions, and to assure long, trouble-free service.

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Simplified construction
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Efficiencies of 96% or higher
Capacities from 1 to 175 h.p.
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When one direction of rotation is desired and reverse direction would cause damage or danger, Line-O-Power Drives may be equipped with the Foote Formspag Backstop. Simple in design, rugged in construction, this unit will give years of service with minimum maintenance.

FOOTE BROS.
Better Power Transmission Through Better Gears



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Please send me a copy of Bulletin LPB on Foote Bros.
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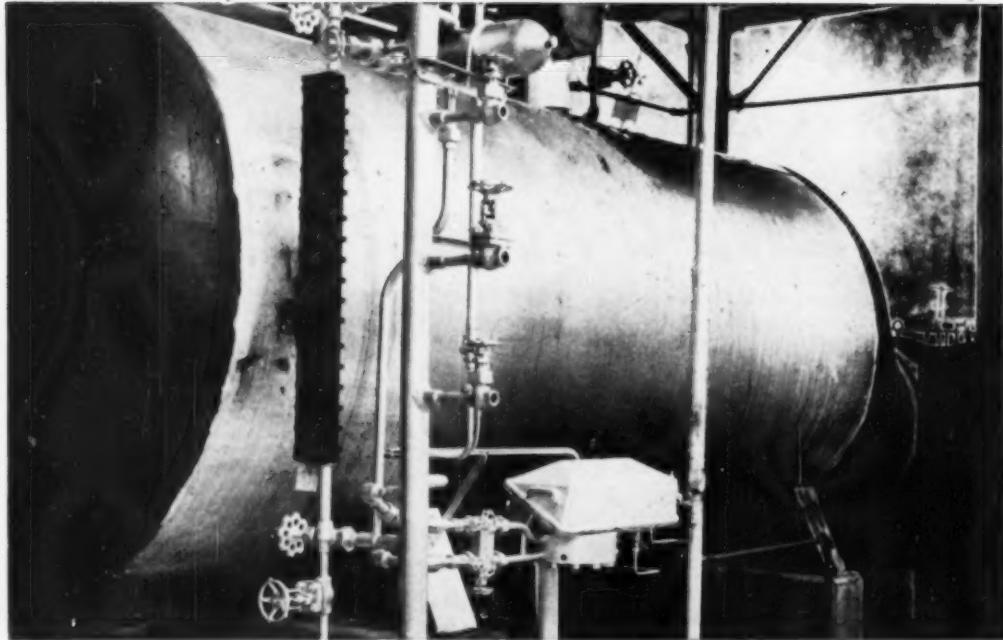
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Republic Transmitter measuring level in reboiler

DIFFERENT... in design and performance

The Republic Pneumatic Transmitter is a device for converting process variables, such as flow, level, pressure or liquid density, into air pressures. These air pressures are a direct measure of the process variables or can be used as the measuring impulse for the actuation of an automatic controller.

The force-balance method of measurement, as employed by the Republic Pneumatic Transmitter, offers many inherent advantages such as:

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AIR SUPPLY PRESSURE—The effects of changes in air supply pressure is so small that it is guaranteed negligible.

LINE PRESSURE—The effect of variations in line pressure has been completely eliminated.

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If you have a flow, level, pressure or liquid density metering or control problem may we suggest that you investigate the Republic Pneumatic Transmitter? Data Book No. 1002, which contains complete details of this instrument, will be mailed to you upon request. Write for it today!

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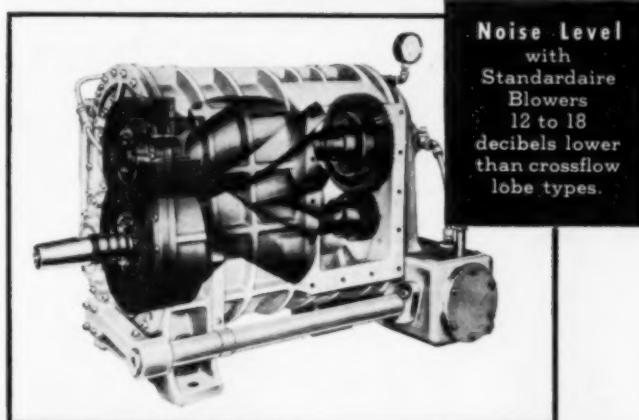
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for every service in
the CHEMICALS and
PROCESS Industries



Fig. 1861—200-pound Stainless Steel Globe Valve with screwed ends, union bonnet, inside screw stem and plug type disc. Available in a variety of other corrosion-resisting metals and alloys.



Fig. 375—200 pound Bronze Gate Valve. Screwed ends, inside screw rising stem, union bonnet and renewable wear-resisting "Powelli-um" nickel-bronze disc.



Fig. 2433 S.S.—Large size 150-pound Stainless Steel Swing Check Valve with flanged ends. All dimensions conform to latest standards. Available in other corrosion-resisting metals and alloys, with body-cap bolts and nuts in Stainless Steel. Also with screwed ends.



Ever since the Special Design and Alloy Valve Division was established—more than a quarter of a century ago—Powell has pioneered in the field of corrosion-resistance.

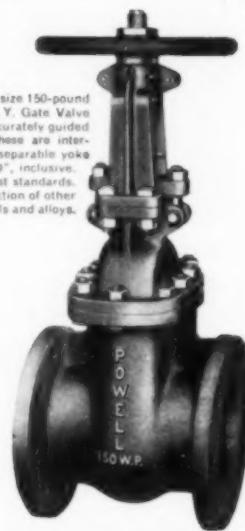
And so today Powell can supply valves made of the right materials* to meet the requirements of every flow control service in the Chemicals and Process Industries.

The Wm. Powell Co., Cincinnati 22, Ohio



Fig. 3003 S. S.—300-pound Stainless Steel O. S. & Y. Gate Valve with tapered solid wedge. Conforms to latest A.S.A. Standards. Available in a variety of other corrosion-resisting metals and alloys.

Fig. 2453 S. G.—Large size 150-pound Stainless Steel O. S. & Y. Gate Valve with precision-fitted, accurately gilded solid or split wedge. These are interchangeable. Made with separable yoke arms in sizes 5" to 30", inclusive. Conforms to all the latest standards. Available in a wide selection of other corrosion-resisting metals and alloys.



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18-8S Ch.	Inconel*	Nastelloy Alloys?	Ampco††	3.5% Nickel Steel
Misco "C"		(A, B, C and D)	Ampco††	6-8% Cr. 5-7.5% Mo.
Durimet 20			76	8-10% Cr. 1.1-1.5% Mo.
11.5-13.5% Cr. Iron	Alcos No. 42		90-10	Silver Hard Lead
18% Cr. Iron	Alcos No. B-214	Alum	88-10-2	Molybdenum
28% Cr. Iron	Alcos No. 61-S-T	D-10		
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*Registered trade-name of the International Nickel Co., Inc.

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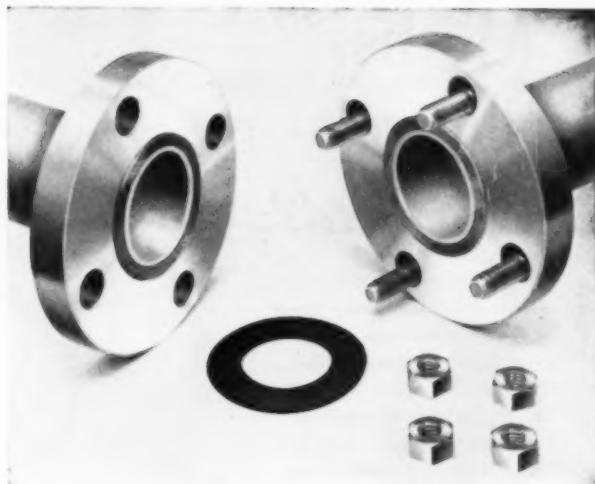
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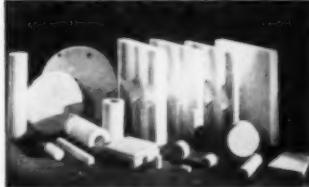
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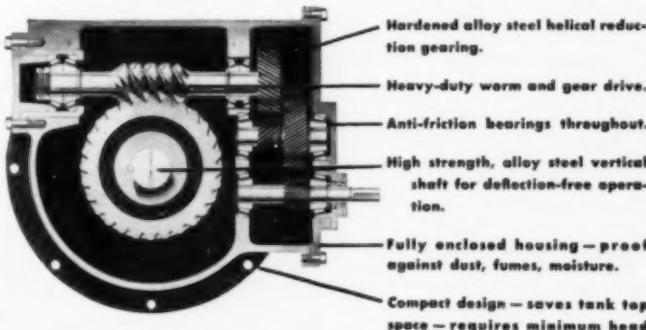
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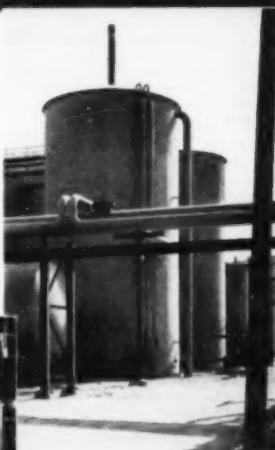
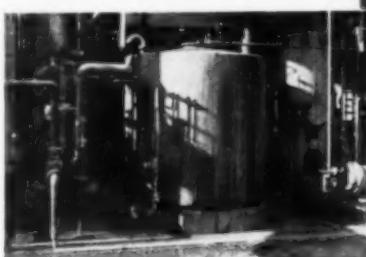
The Hortonspheres are used to store volatile chemicals without excessive evaporation losses. Their spherical shape effectively resists internal pressures and eliminates venting until the pressure exceeds the setting of the relief valve.

The Horton cone roof and umbrella roof tanks are built to special dimensions and used to store caustic solutions.

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Above: Five 7,500-bbl. Horton-spheres—43 ft. 6 in. in diam. storing anhydrous ammonia at a large Texas chemical plant.

Right: 10-ft. by 10-ft. Horton flat-bottom cone roof tank storing low salt caustic.



Above: 20-ft. by 40-ft. Horton umbrella roof tank storing 10 per cent caustic at a large Texas chemical plant.

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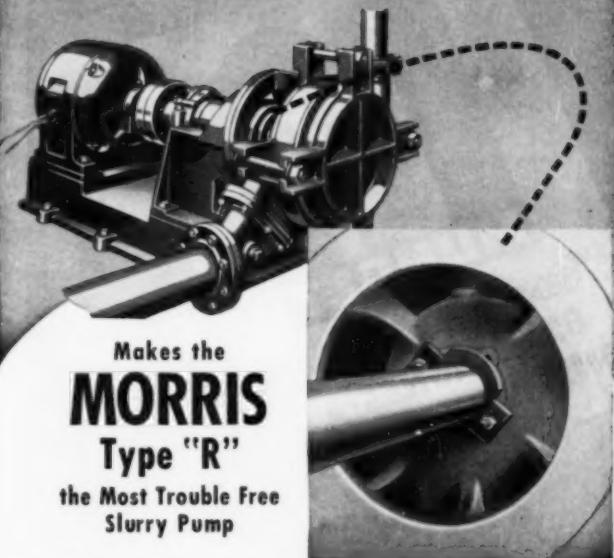
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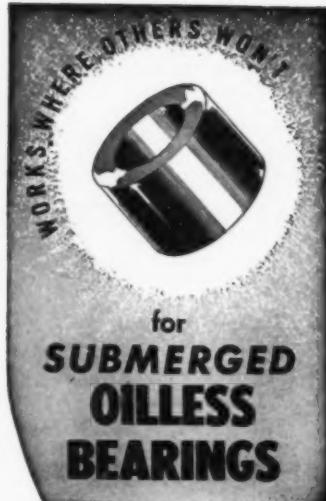
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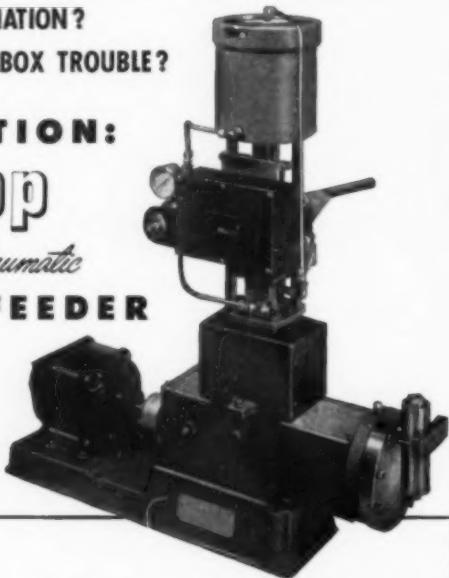
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PULSAFEEDER



Chemicals successfully being handled include gum and sludge inhibitors, metal deactivators, anti-oxidants, dyes and stabilizers. Also those for boiler water or processing water treatment—concentrated sulphuric acid, sodium sulphite, filter aid slurries, liquid caustic. For the Lapp Pulsafeeder is the positive-displacement pump for controlled-volume pumping of liquids which depends on no stuffing box or running seal—avoids contamination by an hydraulically-balanced diaphragm which isolates pumping mechanism from chemical being handled. Pumps against pressures up to 2,000 lbs., at constant pumping speed—variable flow results from variation only in piston-stroke length. Auto-Pneumatic control uses instrument air pressure responding to any instrument-measurable variable.

GOT A SPECIAL PROBLEM? Every month we hear about applications to which the Lapp Pulsafeeder is the long-awaited answer. A newly-issued bulletin, No. 300, will tell you about our pump and its characteristics, with typical applications and flow charts. A Pulsafeeder Inquiry Data Sheet, on which you can outline your processing requirement, will bring an engineering recommendation. Write us today. Lapp Insulator Co., Inc., Process Equipment Division, 537 Maple Street, Le Roy, N. Y.

Lapp
Auto-Pneumatic
PULSAFEEDER



Assures Positive Distance Reading of Liquid Levels

JERGUSON TRUSCALE GAGE

THE modern design JERGUSON TRUSCALE GAGE gives new accuracy for reading of liquid levels in boilers, deaerating tanks, etc.

Here is the remote reading gage which incorporates all of the newest engineering features! The Jerguson Truscale has exceptional sensitivity, with ability to register changes as small as $\frac{1}{2}$ of 1% of range! The translucent dial scale is clearly lighted from behind, and is easy to read.

Available with positive alarm system. Lights and horn signal too high or too low water level.



Visible
Alarm



Horn



Repeater

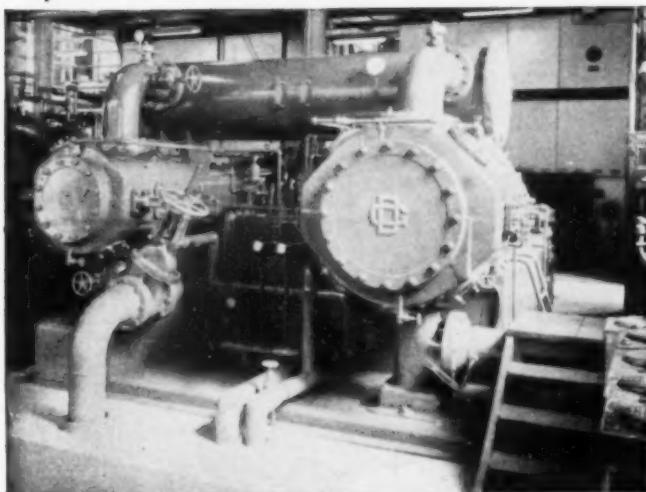
Available with Repeaters which repeat accurate level readings at auxiliary locations.

Marine Operators: Special installation procedure compensates for roll and pitch of your ship.

Write for Truscale Catalog

JERGUSON

Gages and Valves for the Observation of Liquids and Levels
JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Representatives in Major Cities
Phone Listed Under JERGUSON
In Europe: Bailey Motors & Controls, Ltd.



\$1.25

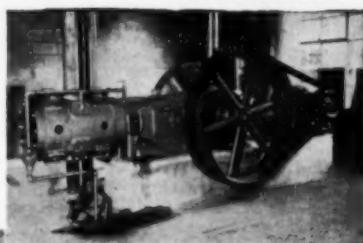
Pin Money Maintenance!

That's all it takes to keep a Gardner-Denver HA Compressor puffing away at top efficiency. One HA, for example, has been handling the full air load in a southern foundry and manufacturing plant for eight years—and has required only \$10.00 for maintenance. That's \$1.25 a year!

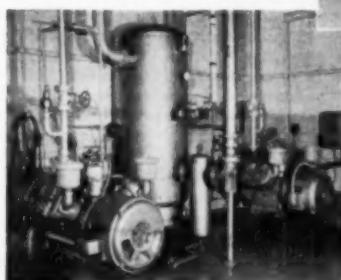
How come? A look at the soundly built power end and the reliable lubricating system will give you some of the answers.

And how about operating costs? They're unusually low, too—thanks to Gardner-Denver correctly designed air cylinders and low-lift "Air Cushioned" valves.

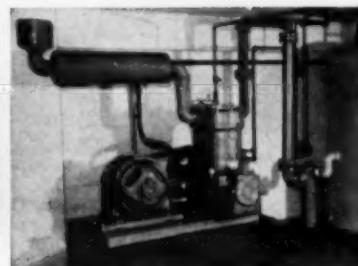
Another dependable compressor
—the Gardner-Denver RX.



Space-saving efficiency—with
Gardner-Denver WB Compressors.



For low-cost compressed air
in any volume—choose
Gardner-Denver
Compressors. Write today
for full details.



For continuous service—
Gardner-Denver AA Compressors.

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GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada:

Gardner-Denver Company (Canada), Ltd., Toronto, Ontario

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS



FLEXONIFLEX

High Pressure

EXPANSION JOINTS

**Flexonics engineered for pressures up to
5500 psi!**



The Flexonics Expansion Joint Design Guide offers helpful data on the selection and application of expansion joints for all services. Write for your copy, today.

With its Flexoniflex line of expansion joints, Flexonics Corporation offers the first practical, in-line expansion joint for high pressure piping systems. Depending upon size and temperature, Flexoniflex units will handle pressures from vacuum to 5500 psi. Temperatures from -400° F. to 1600° F. can be accommodated at reduced pressure at the temperature extremes. Sizes range from $\frac{1}{2}$ " pipe through 6" pipe. Consult Flexonics Corporation's Engineering Department for information on larger sized units.

In construction, Flexoniflex units consist of one or more plies of corrugated stainless steel with integral control rings. They are available with either flanged or welding ends.

If you have high pressure piping we would like to show you how Flexoniflex Expansion Joints can solve your expansion control problems.

Flexonics

Corporation

EXPANSION JOINT DIVISION

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FORMERLY CHICAGO METAL HOSE CORPORATION



Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems • Stainless Steel and Brass Belows • Flexible Metal Conduit and Armor • Assemblies of These Components
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LAMINEX

Trucks & Tanks

MATERIAL: Strong, durable, anti-static, light-weight Fiberglas, densely impregnated, it's proof against rust, moisture, rot, temperature changes, all commonly used chemicals.

CONSTRUCTION: One-piece molding with easy-cleaning rounded corners, no bolts or rivets to snag goods, steel reinforcement — quickly repaired on the spot by unskilled labor.

ECONOMY: Light-weight decreases work loads, easy cleaning prevents smudging goods, quick easy repairs save hours and cost. Priced less than aluminum, about 40% less than stainless steel — for all advantages of best tanks and trucks ever marketed before, plus advantages neither steel nor aluminum can equal. No shortage, nor likelihood of shortage!

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994 Jefferson Street, Fall River, Mass.



A Helping Hand

in many applications . . .

1. REFRIGERANT

2. CHEMICAL REAGENT

3. INERT GAS

4. PRESSURE MEDIUM

5. INGREDIENT

Get all 5 with

RED DIAMOND

Carbon Dioxide

Red Diamond Carbon Dioxide is filling many of the increasingly diverse needs of industry and doing the job better at less cost. As a refrigerant, a pressure medium, an inert gas — in chemical processing and many other applications its use is constantly expanding. Complete technical service is available to industrial users everywhere. Mail the Coupon today.

CO₂ in all its forms by
GAS • LIQUID • SOLID
(DRY ICE)

World's Largest Producers of CO₂
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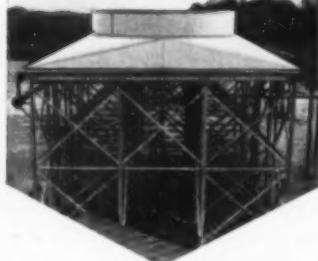


THE LIQUID CARBONIC CORPORATION
155 East 44th Street, New York 17, N.Y.

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Please have one of your engineers see us to discuss
applications of Red Diamond CO₂.

Individual _____
Firm Name _____
Address _____ City _____ State _____

Aeromaster
FANS
 are **BEST** for
 ANY Cooling Job



- Adapted high-speed, top-efficiency aircraft propeller design
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- Longer life—improved anti-flutter performance
- Saves up to 10% in power costs
- Each blade precisely pre-balanced
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- Blade pitch easily adjustable to meet changing power requirements
- Specified as original equipment by many manufacturers
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Koppers Aeromaster Fans are available for any sizable industrial cooling requirement, from diesel locomotives to air-conditioning systems. Standard models, 5 to 24 ft. dia., with 4, 6 or 8 blades per fan. Capacities up to 750,000 c.f.m. Every fan fully guaranteed.

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 Gentlemen: Please send me detailed
 information on Aeromaster Fans for

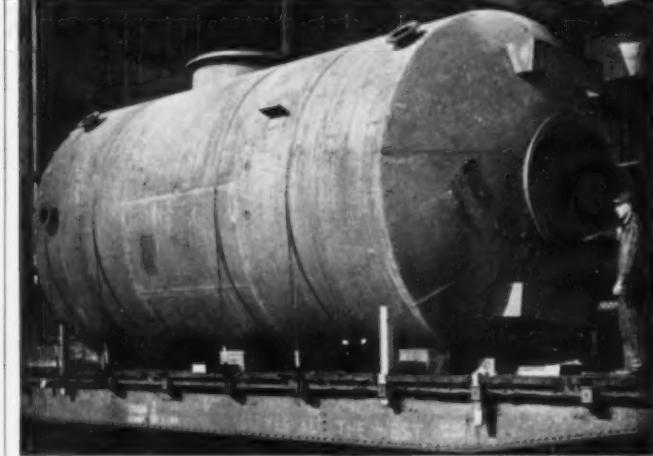
(name and type of equipment to be cooled)

Name _____

Title _____

Company _____

City _____



Pyroflex constructed HCl cooling tower.

PYROFLEX CONSTRUCTIONS

Typical Installations

This engineered functional equipment combines the positive corrosion protection of Pyroflex sheet lining with the rugged strength of acid-proof masonry. However, Knights uses many other types of materials depending on service.

EQUIPMENT	OPERATING CONDITIONS		TIME IN SERVICE
	Service	Temp.	
Absorption Tower	SO ₂ Gas, H ₂ SO ₄ , and Water	700°F	4 yrs.
Chlorinator	Chlorine Benzol and Chlorobenzol	50°F	3 yrs.
Acid Mist Extractor	H ₂ SO ₄ Mist, HCl Gas and Water	250°F	6 yrs.
Cooling Tower	Conc. H ₂ SO ₄ and HCl Gas	1100°F	10 yrs.
Drying Tower	Conc. H ₂ SO ₄ and Chlorine Gas	90°F	5 yrs.
Pickling Tank	30% H ₂ SO ₄	230°F	8 yrs.
Storage Tank	33% HCl and Traces Organic Solvents	85°F	7 yrs.

Autoclaves
 Absorbers
 Acid Boilers
 Concentrators
 Distillation Towers
 Gas Coolers

Gas Washers
 Acid Storage Tanks
 Plating Tanks
 Scrubbers
 Sumps
 Tanks

When inquiring about Pyroflex Constructions, please specify type of equipment in which you are interested as well as service conditions involved. Bulletin No. 2-B will be sent on request.

Maurice A. Knight 105 Kelly Ave., Akron 6, Ohio
Acid and Alkali-proof Chemical Equipment



valveEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



WATER SERVICE—No. 825—36-inch 125-pound cast iron valve equipped with 18—8 shafts, bronze bushings and rubber seat for 85-pound drip tight shut-off.



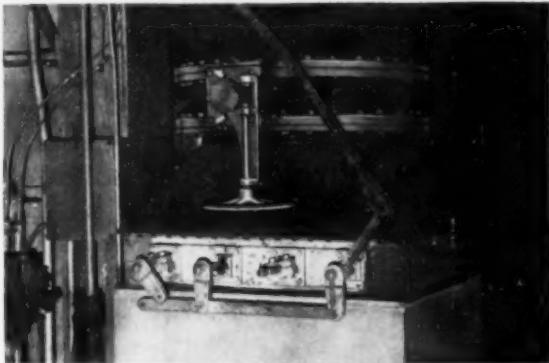
EMERGENCY OIL SERVICE—No. 628—solenoid trip valve. Should the solenoid function, the latch is tripped which causes the counter-weight to open or close the valve by gravity. Available in any metal or alloy and in various sizes for emergency shut-off or vent for air, gas, steam, oil, and water.



700° F. EXHAUST GAS SERVICE—No. 826—6-inch 125-pound R-S "H" metal valve used on small turbine generator. Equipped with 18—8 shafts, hastelloy bushings, finned lubricated stuffing box and solenoid trip mechanism.



STEAM SERVICE—No. 677—1500-pound welding end steel valve for superheated steam—A. S. M. E. Standards.



SEMI-SOLID SERVICE including abrasive and corrosive materials.



R-S VALVES Control and Shut Off Practically Any Material

The beveled vane seats firmly at a $12\frac{1}{2}^{\circ}$ angle and is closed from a fully open position through $77\frac{1}{2}^{\circ}$ of arc by either manual or automatic operation. A metal-to-metal seat gives satisfactory commercial shut-off. When required, Monel or stainless steel can be welded to the vane periphery and a babbitt seat used in the valve body. Drip tight or bubble tight closure can be obtained with a rubber seat.

Power controlled prime movers delivering the necessary foot pounds of torque open or close these self-cleaning valves at any desired speed from one second to eight minutes according to requirements. Pressures range from 2 to 2500 psig and temperatures from minus 300° F. to plus 2000° F.

Such simplicity of design, adaptability and operating ease are the reasons why R-S Valves can be installed to control and shut off the volume and pressure of any material that flows or is forced through a pipe.

Obtain full details from your R-S representative.

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.

An S. Morgan Smith Company Subsidiary

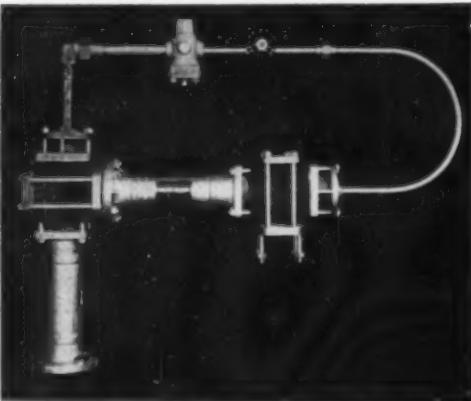
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NOTES

for Process Engineers

COOLING TOWERS—VACUUM REFRIGERATION—HIGH VACUUM PROCESS EQUIPMENT—MICRO-PARTICLE REDUCTION MILLS—STEAM CONDENSERS—STEAM JET EJECTORS—MARINE CONDENSERS & EJECTORS—DECK MACHINERY

C. H. Wheeler
OF PHILADELPHIA



Two-stage non-condensing impervious graphite ejector

Send for catalog 1462. It contains helpful tables and tips on Steam Jet Vacuum problems. It also describes the complete line of C. H. Wheeler Tubejets. It will be mailed at no obligation to you.

"SELF-CLEANING" CONDENSERS by REVERSE FLOW featured in C. H. WHEELER Bulletin

The C. H. Wheeler Manufacturing Company's unique design of an integral reverse-flow steam condenser provides the most practical method yet devised for cleaning the tube sheet, and eliminates the need for expensive mechanical water straining apparatus. A recently issued bulletin tells how it works.

For C. H. WHEELER Literature

Attach this Handy Form to Your Company Letterhead

Interested in following literature

- Steam Jet Ejectors (catalog 1462)
- "Self-Cleaning" Reverse-Flow Steam Condensers

Your Name _____

Your Job _____

(Literature will be mailed to address shown on your company letterhead)

STEAM JET EJECTORS Made of IMPERVIOUS GRAPHITE For Handling CORROSIVE VAPORS

If your vacuum equipment is inefficient due to corrosion from acid fumes, this item holds an answer to your problems.

For highly corrosive acids such as sulphuric, hydrochloric, nitric, etc. C. H. Wheeler impervious graphite ejectors are recommended. The impervious graphite is enclosed in a steel or cast iron casing to prevent breakage. It is light in weight, non-porous, with low coefficient of thermal expansion and high resistance to thermal shock. Impervious graphite is most commonly recommended for the single and two-stage non-condensing ejectors.

C. H. Wheeler Ejectors can also be furnished of other materials such as acid resisting bronze, monel and stainless steel where the corrosive action of the vapors being handled does not require the use of impervious graphite construction.

C. H. WHEELER & ECONOMY PUMPS, Inc. CONSOLIDATE TO SERVE YOU BETTER

Economy Pumps, Inc. and C. H. Wheeler Manufacturing Company have consolidated engineering and manufacturing facilities in C. H. Wheeler's plant at Philadelphia. Facilities are now being expanded through new construction and the installation of additional modern machine tool equipment.

PUMPS . . . Economy has for many years been among the leaders in the engineering and manufacture of centrifugal, axial and mixed flow pumps. Today, the Wheeler-Economy line is one of the most modern and complete in the pumping industry.

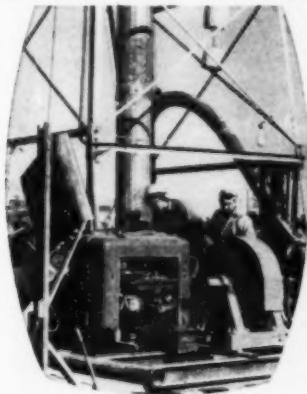
PROCESS EQUIPMENT . . . C. H. Wheeler is internationally known for Steam Jet vacuum apparatus, Fine Particle Reduction Mills and Cooling Towers, vital links in modern chemical and food processes. Wheeler-Economy Pumps will round out the company's services in these fields.

For information write to Philadelphia or to the nearest Economy or Wheeler representative listed in the phone directories of principal cities.

C. H. WHEELER MANUFACTURING CO., 1832 SEDGLEY AVE., PHILADELPHIA 32, PA.

"Making Hole"

is just part of our job



To the well driller "Making Hole" means that everything is running smoothly and the hole is getting deeper and deeper. But to Layne, "Making Hole" is just part of building a fine well water supply.

Before a single rig is placed, Layne has used a lot of know-how planning, plotting and figuring out such things as: what size casing and what depth it is to be set, what kind and how much sand screen to use, what kind and size shafting to use and how much horse power or the motors should have to produce the stipulated amount of water against a certain indicated pressure. Once all of these answers are on paper, they must be transmitted into an underground construction project;—task that requires a lot of skill and ability.

But whether for a single unit or many, you may be sure that if installed by Layne, all will have the same peak efficiency, operate with precision smoothness and be of utmost dependability for now and the years to come.

For late catalogs or specific information on any phase of Layne's water development services, address

LAYNE & BOWLER, INC.
General Offices, Memphis 8, Tenn.

Layne

**WATER WELLS
VERTICAL TURBINE PUMPS
WATER TREATMENT**

Put the heat on dehydrating problems

A Kirk & Blum Oven removes 900 lbs. of water from 1700 lb. chemical load at Tennessee Eastman Corp., Kingsport, Tennessee.

with a
KIRK AND BLUM
oven

Specially designed to solve difficult problems . . . KIRK and BLUM Ovens meet any dehydrating needs. The large oven illustrated was built to insure complete removal of moisture as it is taken up by warm air . . . eliminating subsequent deposit on other trays. Four separate compartments each individually controlled for temperature and air circulation in this steam heated oven allows removal of finished loads at any time.

This KIRK and BLUM Oven was shipped completely assembled, thoroughly tested and ready to operate.

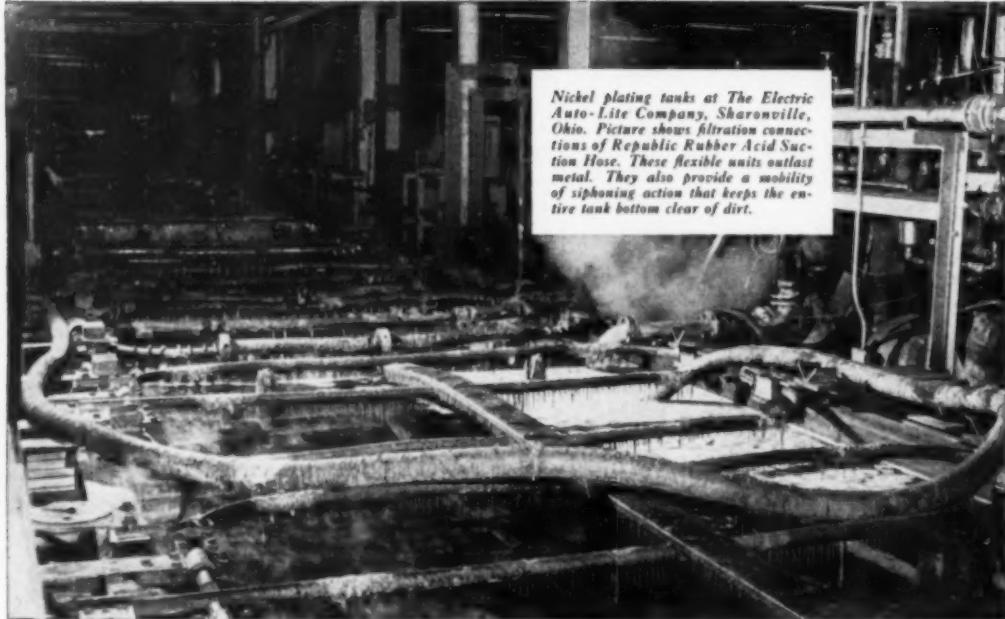
It is another example of the diversity of drying problems skillfully solved by KIRK and BLUM engineers. If you have a problem involving ovens . . . feel free to consult with a KIRK & BLUM engineer . . . there is no obligation.



Write for booklet . . . "Industrial Ovens".
The Kirk & Blum Mfg. Co., 3208 Forrer Street, Cincinnati 9, Ohio.

LABORATORY OVEN . . . electrically heated . . . automatically controlled and timed . . . suitable for test and research . . . or for small production.

KIRK AND BLUM
LABORATORY AND
INDUSTRIAL OVENS



Nickel plating tanks at The Electric Auto-Lite Company, Sharonville, Ohio. Picture shows filtration connections of Republic Rubber Acid Suction Hose. These flexible units outlast metal. They also provide a mobility of siphoning action that keeps the entire tank bottom clear of dirt.

Case history of—HANDLING ACID THROUGH RUBBER HOSE

Getting a flexible carrier that could handle nickel plating solution was the problem facing The Electric Auto-Lite Company, Sharonville, Ohio.

The solution, in addition to being highly acid, is saturated with ionized particles of nickel. Ordinary rubber hose had a tendency to pick up these particles. What's more, the acid eventually penetrated to inner hose reinforcements, which were destroyed.

Carriers of metal pipe were no better. In the first place, they weren't flexible. The acid slowly dissolved the pipe wall, leaving a dangerously thin shell that could give out any time without warning.

What was the answer? Well, Auto-Lite called in their local Republic Rubber Distributor, an expert in Industrial Rubber applications, who recommended use of Republic Acid Suction Hose.

This flexible carrier is specially built to withstand action of either acids or alkalies. It's made with rugged abrasion-resistant cover, a sealed-in, metal-reinforced carcass and a tube that can handle caustic liquids at temperatures up to 150° F.

The Electric Auto-Lite Company is highly pleased with the performance of this Republic Rubber Hose. They like the quick, sure way Republic Distributors diagnose, then solve difficult problems in the application of Industrial Rubber Products.

We suggest that you may also enjoy doing business with a company that for 52 years has specialized both in building better rubber products and giving you better service at the local level.

Write today for special product information and the name of your nearby Republic Distributor.



INDUSTRIAL RUBBER PRODUCTS BY
REPUBLIC RUBBER DIVISION
Lee Rubber & Tire Corporation
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DUST

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Oklahoma

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Pennsylvania

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CHEMICALS in California

CARBON BLACK in Texas

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— just a few representative
dusts collected in thousands of

SLY DUST FILTERS

• Sly pioneered and leads in
industrial dust control.

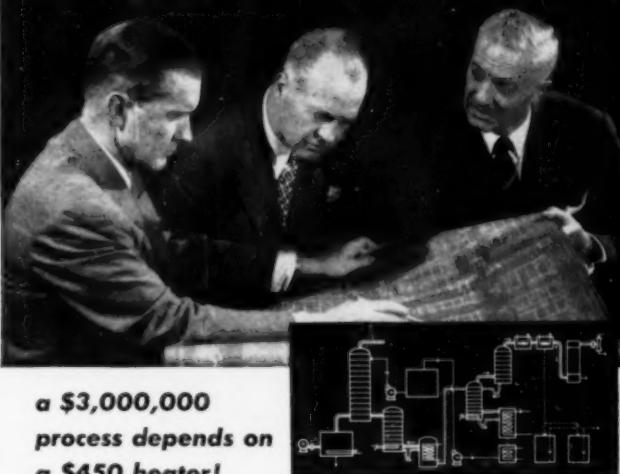
Sly representatives are trained
and experienced engineers.

Your dust problem, large or
small, can be solved by a Sly
dust expert.

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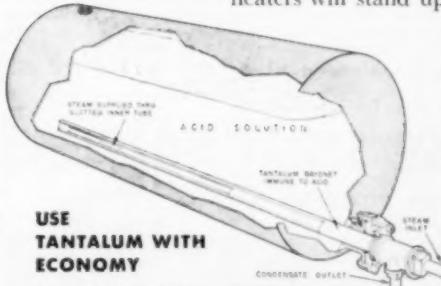


a \$3,000,000
process depends on
a \$450 heater!



Acid-Proof TANTALUM Bayonet Heaters

"If this one little heater goes out, we would have to shut down \$3,000,000 worth of associated equipment. We can't take that chance. We know that tantalum heaters will stand up. Put them in!"



TANTALUM BAYONET HEATER

Simple, efficient, economical. Requires only one gasketed connection. Impossible to become air-bound or water-logged when properly installed.

for most acid solutions, corrosive gases or vapors; not with HF, alkalis or substances containing free SO₃.

WRITE FOR INFORMATIVE BULLETINS ON ACID-PROOF TANTALUM CHEMICAL EQUIPMENT



Acid-Proof

TANTALUM

22404C

Fansteel Metallurgical Corporation

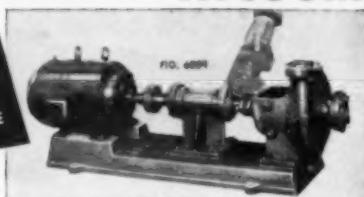
NORTH CHICAGO, ILLINOIS, U.S.A.

TABER for Higher **PRACTICAL** Performance

PUMPING UNDER VACUUM



BULLETIN
CL-339
AVAILABLE



NO LEAKAGE THRU STUFFING BOX IN HANDLING CHEMICAL SOLUTIONS.

When in vacuum service on evaporators, the Taber drip chamber prevents air from entering thru the packing. The illustration above indicates how this is accomplished. • Water-sealing of the stuffing box is absolutely dependable.

Many of the foremost companies in the chemical and processing industries rely on adaptable, efficient Taber Single Suction Centrifugal Pumps. Built in any metal or alloy obtainable as specified by customer. • Please use business stationery when writing for Bulletin CL-339.

TABER PUMP CO. (Est. 1859) 294 Elm St., Buffalo 3, N. Y.

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• SPRAYING • WASHING • RINSING • COOLING • AIR CONDITIONING

Get the most out of your Spraying Equipment with minimum power ... with efficient spraying.

Use Yarway Nozzles. No internal vanes or other restrictions to clog or hinder flow. Two types—Yarway Involute-type producing a fine hollow spray with minimum energy loss, and Yarway Fan-type producing a flat fan-shaped spray with time-saving slicing action for cleaning.

Wide range of standard sizes and capacities. Cast or machined from solid bar stock.

Thousands in use. Write for Bulletin N-616.

YARWAY SPRAY NOZZLES

YARNALL-WARING COMPANY

137 Mermaid Avenue, Philadelphia 18, Pa.

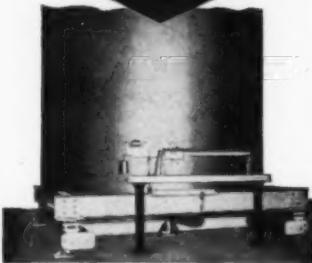
INVOLUTE-TYPE FOR HOLLOW CONE SPRAY



FAN-TYPE FOR FLAT SLICING SPRAY



FOR WEIGHING CONTENTS OF TANKS and HOPPERS



Manufactured to special size—for your tank
or hopper—vertical or horizontal

WINSLOW 150,000 LB. TANK SCALE

Can be furnished for use with cone shape or flat bottom tanks—with either direct reading weigh beam or ticket printing weigh beam. Ticket printing beam prints weights with 5 lb. or 10 lb. minimum graduation.



TYPE "A" RECORDING BEAM

This weighing equipment is in use by large and small industrial plants—throughout the United States—and specified by some of the country's largest consulting and construction engineering concerns.

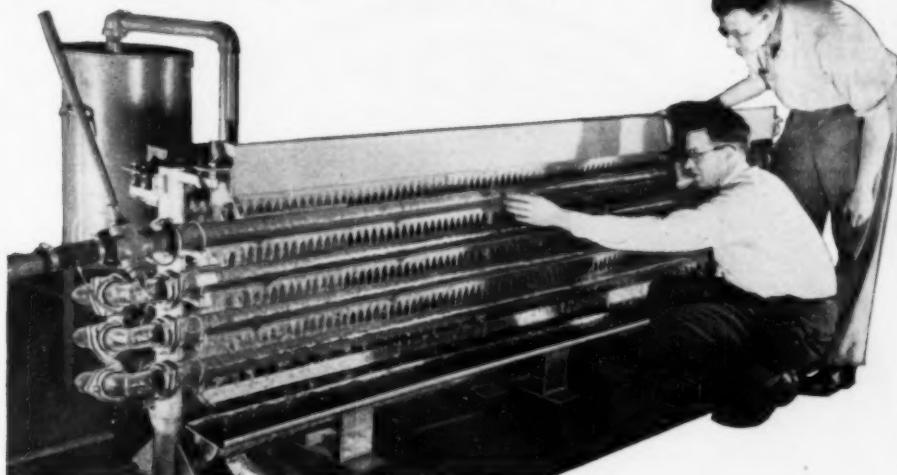
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Winslow
tank scales

Manufactured by

WINSLOW SCALE COMPANY
No. 239 Street • Terre Haute, Indiana

Only PYREX® CASCADE COOLERS give you double protection against corrosion



- ① Stop chemical attack inside tubes
- ② Permit use of low cost water as coolant

You're doubly protected against corrosion—doubly assured of processing economies with PYREX brand Cascade Coolers. First, you can count on long service life with low replacement costs because of their exceptional resistance to practically all liquids. Second, you can use low cost sea or river water as a coolant. Then, too, PYREX Cascade Coolers offer you:

DURABILITY—They withstand rapid temperature changes and mechanical shock and the corrosive action of chemicals.

ASSURED PRODUCT PURITY—They provide positive protection for CP chemicals, drugs, foods and other products susceptible to contamination.

FURTHER ECONOMY—Low in first cost per

BTU transferred, PYREX brand Cascade Coolers have "glass-smooth" surfaces which resist scale formation—keep efficiency up . . . cleaning and maintenance costs down.

HIGH VERSATILITY—You can mount them on floor, wall or ceiling to conserve space—use them in series or parallel. Shipped complete, an eight-tube unit requires only a few hours for assembly by your own men.

Handy nomographs and tables to help you compute your heat transfer requirements, along with a complete description of PYREX Cascade Coolers are included in Corning's new Technical Bulletin PE-8. Send for your copy today. Mail the coupon below.



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CORNING, NEW YORK

Corning means research in Glass

Visit the new Corning Glass Center



CORNING GLASS WORKS, Dept. CE-S, Corning, N.Y.

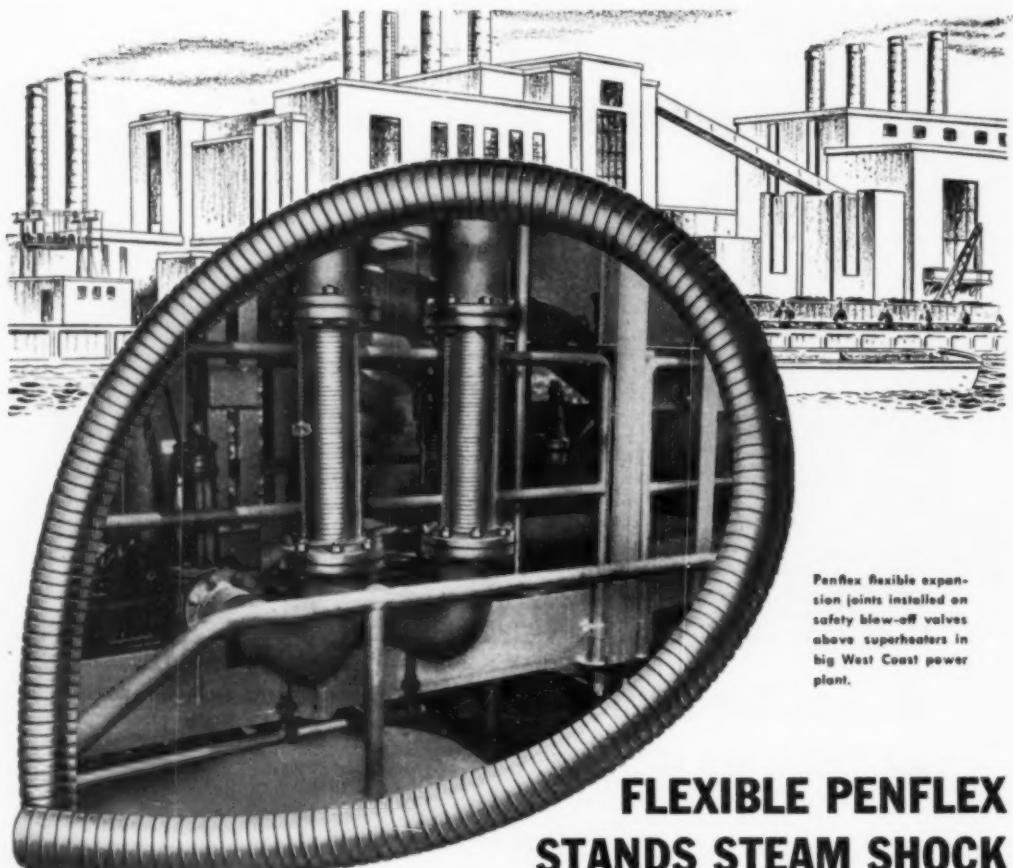
Please send me a copy of Technical Bulletin PE-8, "PYREX Cascade Coolers" and name of nearest distributor.

NAME TITLE

FIRM

ADDRESS

CITY ZONE STATE



Penflex flexible expansion joints installed on safety blow-off valves above superheaters in big West Coast power plant.

FLEXIBLE PENFLEX STANDS STEAM SHOCK

PENFLEX TUBING ABSORBS THERMAL EXPANSION . . . PREVENTS BLOW-OUT

Without warning, the safety valves atop these big superheaters suddenly pop. A mighty surge of 900 F., eight-hundred-and-fifty-pound steam blasts through the pipes to exhaust to atmosphere. These pipes have to know how to take it!

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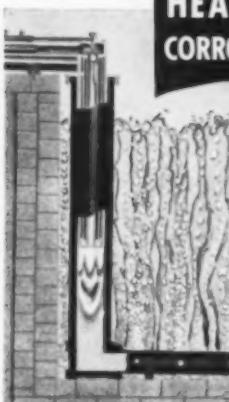
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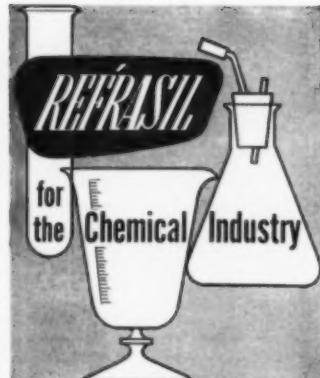


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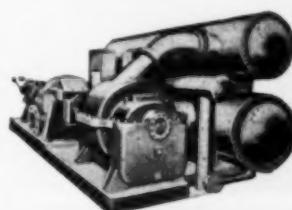
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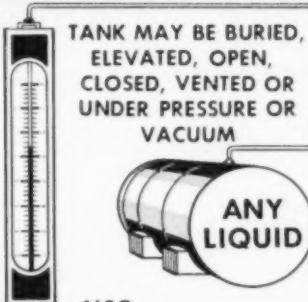
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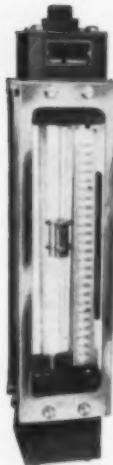
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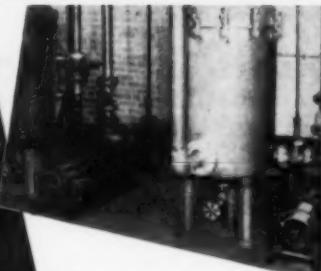
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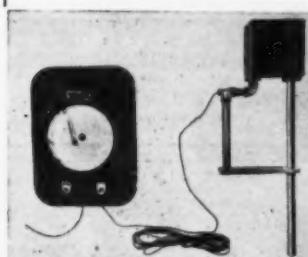
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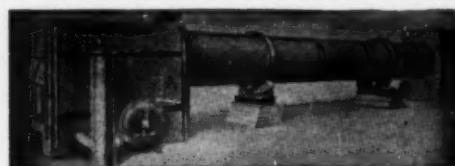
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NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)**POSITION VACANT**

CHEMICAL ENGINEER—Challenging position for man with exceptional ability, initiative and enthusiasm of mind and experience to manage production for established organic chemical manufacturer. Write fully including recent photograph. P-2837, Chemical Engineering.

SELLING OPPORTUNITY OFFERED

SALES REPRESENTATIVE wanted—Phenolic Resins. Willing to make commission arrangement if so desired. One man has been advised about this advertisement. RW-4272, Chemical Engineering.

EMPLOYMENT SERVICES

SALARIED POSITIONS \$3,500 to \$35,000. We offer the original personal employment service (established 42 years). Procedure of highest ethical standards. No cost to you. Your personal requirements identified; present position protected. Ask for particulars. R. W. Bixby, Inc., 260 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL \$3,000-\$25,000. This confidential service established 1927, is geared to men of high grade who seek positions of considerable responsibility. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. B, 241 Orange St., New Haven, Conn.

POSITION WANTED

EXECUTIVE CHEMICAL Engineer — Registered PE, 50, with substantial experience in plant management and engineering in alkali and organic field. Excellent record of getting results. Good opportunities available in plant management, multiplant production supervision, engineering, or consulting organization. PW-2919, Chemical Engineering.

INFORMATION

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads. (not including proposals).

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

DISPLAYED RATE:

The advertising rate is \$11.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page. C. E.

VISCOSE ENGINEER

National organization seeks capable graduate engineer with experience in viscose rayon manufacture or related experience. Headquarters New York. Salary open.

Send complete resume including age and salary data
Box CE 698, 221 W. 41 St. New York City 18, N. Y.**Chemical Engineer**

Wanted Technical service on new continuous melt process, and related chemical industries. Excellent opportunity for young man — two years experience process equipment. Ability to meet top-level customer personnel—some travel required.

Mr. John A. Abbott

American Machine
& Foundry Co.

485 5th Avenue, New York, N. Y.

SALES ENGINEER WANTED**To Sell Chemical Process Equipment**

A chemical engineer or with equivalent knowledge—experienced in selling chemical process equipment. A wonderful opportunity to eventually head up sales department for large Cincinnati, Ohio company. Must be able to travel. Salary plus commission. Write previous experience, qualifications, enclose photo if possible. Replies confidential.

SW-4155, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.**Latin American Service**

We are looking for a man capable of heading a Latin American chemical plant after a training period in our factory. Give complete information on education, experience, earnings, responsibilities, references, etc.

P-4029, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.**SELLING OPPORTUNITY WANTED**

U. S. MANUFACTURER of chemical specialties and dyes, with salesmen in Ontario and Quebec, office clerical staff, laboratory, and warehouse in Montreal, now needs a medium representation and distributor for an additional line. RA-2998, Chemical Engineering.

FOR SALE**Years Plant,**

including Turbo-Blowers of modern design in excellent condition, available for immediate delivery from factory. Price—about £1000 in England. P-3504, Chemical Engineering.

WANTED

ANYTHING within reason that is wanted in the field served by Chemical Engineering can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

**Business Opportunity
Advertising
on the following page****EXCLUSIVE REPRESENTATION WANTED**

L.A. SOUTH MISS., MOBILE AREA by well established firm of Mfrs. Agents with two young, aggressive Registered Prod. Engrs. presently handling contracts with major oil companies. Mfrs. Prefer heavy equipment field applicable to Petro. Industries, Chemical Plants, Paper and board mills.

PW-3647, Chemical Engineering
330 W. 42nd St., New York 36, N. Y.**SALES MANAGER
INDUSTRIAL WAXES**

Large corporation requires services of sales executive having broad experience in sales to industrial consumers. Applicant should have previous sales management background in this field and be capable of establishing sales organization. This offers excellent opportunity with old established company. Eastern location. Reply completely, giving education, business background, salary desired, etc.

SW-4115, Chemical Engineering
230 W. 42 St., New York 36, N. Y.WANTED
CHEMICAL ENGINEER
Must be experienced with all phases of water treatment applicable to a high pressure steam generating station, also coal and oil combustion systems, industrial chemical installations involving fire tube boilers, 625,000 KW capacity—1000 psig steam pressure—1000°F/1000°F temperature.
Also Wanted: CONTROL ROOM OPERATORS
Electric Energy, Inc., Jepco, Illinois

Maybe I'm wrong-but...



Pages from my Notebook

by Lawrence Gelb

"De Gustibus"

"Every one to his own taste", as Caesar may have said. There are those among us that swear by glass-lined tanks for storing chemicals. "Their virtues are without number". "Their efficiency is beyond compare". Others are not quite so complimentary, particularly where used glass-lined tanks are concerned. Oh yes, we have them in stock. But we're not proud of them. We advise our purchase only when nothing else will do. Why? Because of the constant attendant on the use of corrosive solutions and the constant threat of failure in glass-lined tanks that have been transported improperly, poorly set on foundations, inadequately tested prior to purchase, or stupidly stored. We never feel too happy about selling these items to our customers!

Come to think about it, this is no way to sell. It may be just a sort of silly fancy with us. Maybe we're losing a lot of sales. But maybe we are making a lot of friends.

What do you think?

Sincerely,
Lawrence Gelb

P.S.

I think glass-lined tanks are wonderful, if a girl wants to show her swimming form, don't you?

The Gelb Girl



R. GELB & SONS, Inc.

CHEMICAL RUBBER, OIL, PLASTIC AND FOOD PROCESSING MACHINERY
STATE HIGHWAY NO. 29, UNION, N. J.
UNIONVILLE 2-4900

NEW PRODUCT WANTED

Southern non-ferrous smelter, desirous of diversification, will consider adding new product to present line, or might build and manage small chemical or metallurgical plant.

Has excellent contacts in the scrap trade, good location, and competent staff. Railroad trackage and other facilities.

Favorably located for the southern United States and Latin American markets.

Interested firms are asked to write to:

BO-1017, Chemical Engineering
330 W. 42nd St., New York 36, N. Y.

CHEMICAL PLANT WANTED

We are now manufacturing over \$20,000,000 in various lines and wish to expand by acquisition of assets or stock of one or more industrial companies. In our negotiations the sellers' problems and wishes will receive full consideration. Present personnel will normally be retained.

Address all replies

"Confidential" C. J. GALE, Sec.
233 Broadway, N. Y. 7, N. Y. BA 7-1819

Available { CUSTOM REFINING FACILITIES
• Distillation • Extractions
• Separations • Fractionation
Drum Lots—Tank Cars

Wanted { All Types of Crude Mixtures
• By-Products, Residues, Wastes
Contaminated Solvents

**TRULAND CHEMICAL &
ENGINEERING CO., INC.**

Box 438, Union, N. J. UNIONVILLE 2-7360

WILL BUY

Cancelled - Unshipped - Rejected
or Over-Stocked

CHEMICALS—DRUGS
SOLVENTS
PHARMACEUTICALS
OILS—PIGMENTS, ETC.

Chemical Service Corporation
80-04 Beaver St. New York 5, N. Y.

WANTED

Vacuum Dryers, Heavy Duty Mixers, Reactors, Kettles, Columns, Rotaries, Filter, Pulverizers, Filter Presses, S/S and non-corrosive Tankage, Idle or Set Up Plant.

P. O. BOX 1351
Church St. Sta. New York 8, N. Y.



**Oldest and
Largest Dealer
in Rebuilt
Chemical
Machinery**

•
**For 35 years
Leaders in
Our Field**

•
**Buy with
Confidence**

•
**Sell your idle
Machinery
to**

"CONSOLIDATED"



Our 35th Year of Growth "CONSOLIDATED"

Thanks to your well placed Confidence

EXTRAORDINARY OFFER RECENT PURCHASE

- 1—Devine #21 Vacuum Shell Dryer, 13 shelves 38"x38", Condenser and Pump.
 - 2—Devine #22 Vacuum Shell Dryers, each 20 shelves 58"x78", surface condensers and vacuum pumps.
 - 3—Ball & Jewell #22 Rotary Cutters.
 - 4—Tolhurst 4" steel basket Centrifugal, suspended type, bottom discharge.
 - 5—Troyer Tube Mills, 3"x12", 3"x20", 4"x10", 4"x12", each stone-lined, screw feed, pebble charge, clutch pulley.
- Still installed in one plant as operated, with all accessories as used.

FILTERS & FILTER PRESSES

- 1—American Disc Filter 6' dia., 2 disc, 100 sq. ft. filtering area comp/w auxiliaries.
- 2—Shriver, iron steam heated, 38"x30".
- 3—Shriver, iron steam heated, 38"x30".
- 4—Shriver & Johnson, 30x30 iron plate and frame, 35—40 chambers each.
- 5—8"x12" Oliver Leaf-Wood Vacuum Filter Acid-Resisting.
- 6—Oliver Leaf-Wood Filters, incl. #812, 11"x14", 11"x18".
- 7—ALUMINUM Sperry FILTER PRESS: 1—30"x30", 45 chambers.
- 8—#12 Sweetland Filter, 36 leaves 4" c.c.
- 9—Killy 38x38 CI Filter Press open delivery.
- 10—Sperry 24"x24" P. & F. Filter Press with 25 chambers, 2" frames.

EVAPORATORS

- 1—Swenson triple effect Evaporator, horizontal copper tubes, total 1320 sq. ft. H.S. Now installed and complete with supporting steel, condenser, pumps, piping, etc.
- 2—Swenson triple effect Finishing Frame.
- 3—Swenson single effect Evaporator, copper tubes, 440 sq. ft. H.S. with supporting steel, condenser, pumps, piping, etc.

CENTRIFUGALS

- 2—42" All STAINLESS STEEL Centrifugals, Amer. T&M Co. with S/S basket, carb. casing, shaft unloader and 40 H.P. variable speed Slip Ring 3/60/440 V 1200 RPM motor with full controls. Suspended bottom discharge type. Now at Newark.
- 1—Tolhurst susp. Centrifugal with per. 40 H.P. MONEL basket, carbon discharge, 3 speed, 28 h.p., 5 h.p., 3/60/440V Motor. All contact parts Monel. Still erected, can be seen in operation.

DRYERS

- 2—L.R. Roto Louvre Dryers, #207-10 and 705-20.
- 3—5"x6' Ruggles-Cole direct heat Rotary Dryers.
- Also Class A2, 4"x20'; Class XF-4, 34"x25'.
- 1—5"x14' Direct Heat Rotary Dryer or Rotary Kiln, welded shell.
- 1—2"x20' Louisville Type L, Indirect-Direct Heat Rotary Dryer.
- 4—Bulovak 3"x12' double drum Dryers.
- 1—Devine #7 Vacuum Shell Dryer, 13 shelves 48x43.
- 1—Bulovak Double Drum Dryers 32"x30" complete with stainless steel accessories; 1-American 42"x125".
- 1—Devine Rotary Vacuum Dryer, 2"x8", also 8"x25".
- 2—Bulovak Vacuum Drum Dryers, 5"x10' with all accessories.
- 1—6x30 Louisville welded shell Rotary Steam Tube Dryer with two rows, 54 tubes. Also two 6"x27" Davenport same type, also 6"x35" Louisville with stainless steel tubes.

MIXERS

- 2—Beard and Day 50 gal. double arm Mixers.
- 4—Baker Perkins Jack Mixers, 3,000 gal., size 38, type X.
- 1—100 gal. Jack, B.P. Mixer, heated blades.
- 1—Patterson 110 gal. S.S. Vacuum Knead-mixer.
- 2—Libbey St. Jack, horiz. Ribbon Mixers 14"x6" 10", stuffing boxes, 600 cu. ft. capacity.
- 1—AMF 240, 160, 120 qt. Glen Mixers, S/S bowls and beaters.

SPECIAL OFFERING

- 1—40" 2 roll Compounding Mill with enclosed reduction unit & 150 HP synchronous motor and controls.
- 10—18"x18" 3 opening, 88 ton, hydraulic Presses, steam heated platens.

JACKETED KETTLES

- 1—1,000 gal. Stainless Steel, jacketed & lined.
- 1—10" dia. x 4' Bartlett and Snow 1800 gallon, with agitator, 8/16" plate, 140 lbs.
- 3—1200 gal. Steel Steam Jacketed Kettles, closed.
- 5—Deep kettles, 100, 150, 350 and 600 liters.
- 2—Steel Jack, agitated, 400 and 800 gal.
- 1—500 gal. open agitated.
- 2—Lee 200 gal. S/S 125"; 1—300 gal. S/S, 100".
- 4—Burkhardt copper, 275 gal.
- 1—100 gal. and 3—150 gal. Dopp C.I. dht. motion, agitated.

MISCELLANEOUS

- 1—Ball & Jewell #22 Rotary Cutter.
- 1—Stokes Raymond H.S. Mill, #2827.
- 1—Stokes 5" single punch Tablet Machine.
- 1—Weidelt Tanks, 1,500 gal., horiz., 3" dia. x 11'.
- Battery of 4—Steel all welded Jack Tanks, closed top, 1,800 gal. cap., complete with steel supports and cutwalks, recording instruments, etc.
- Bettcher 5—Steel all welded Jack Tanks, open top, 9,500 gal. cap., agitated.
- 1—6"x14" Hardinge Rotary Counter Current Classifier, also for dewatering or scrubbing.
- 2—Dorr two-stage classifiers, each with two rakes, total length 27', gear reducer and motor.
- 1—Dorr 4"x20" 2" Bell Granulator, iron lined. Used 120 hours.
- 2—Smith 5"x20" Tube Mills, iron lined, each with Bell Charge and 3/60/2300 volt motors.
- 4—33047 Raymond High Side Roller Mills, each complete with Two 30" H.P. 3/60/440 volt motors, separator, exhaustor, cyclone connecting piping, etc.
- 4—Micro Pulverizers, Model 4TH, 24", #231, #27H.
- 1—Copper Rectifying Column, 8 sections, 30" dia. x 33" high, bubble cap type.
- 15—Dry Powder Mixers and Blenders, varying sizes and horizontal ribbon type, up to 5000 lb. capacity.
- 1—Capen, S.I.F. Copper, cap seeder.
- 2—Swenson Walkar, skid, Crystallizers.
- 2—Bulovak 8" dia. vacuum Crystallizers.
- 1—Bulovak 6" dia. Atmos. Jack, Crystallizer.
- 1—34"x18" Shutevent Jaw Crusher to 1/2".
- 1—34"x18" Shutevent Crushing Rolls, balanced type.
- 8—Forcalin Lined Pebble Mills, 6"x8" 800 gals., 5"x4" 235 gals., 2"x3", 30 gal.

ONLY A PARTIAL LIST—SEND FOR COMPLETE LISTING

The Oldest and Largest Dealer in Rebuilt Chemical Machinery
SOLIDATED PRODUCTS COMPANY INC.

2015 PARK ROW BLDG. N.Y. 38 N.Y. BArclay 7-0600 Cable Address EQUIPMENT

LIQUIDATION

FROM NIAGARA FALLS, N. Y.

**Everything must be removed within 30 days.
First-class equipment priced to sell. Act Now!**

AMINES UNIT

2-6'x47" Absorber Columns.
1-5'x38" Still.
1-7'x16" Reboiler.

(All equipment mf'd by Brown, ASME welded)

OXIDATION UNIT

2-7'9"x19'9" Oxidizers, refractory lined,
direct fired.
1-5'x42" Packed Tower.
2-Knots Blowers, 14"x18".
3-Complete Gas Cracking Furnaces, 25'x8'6"x9', with chrome coils and gas burners.

SULPHUR REMOVAL UNIT

Thionizers—4'x6' & 12'x58".
Absorbers—1'6"x58" & 3'6"x58"
Separator—3'x7".

(Interconnecting piping & valves are with all units.)

Centrifugal Pumps, Cameron size 4LV and
I.R. 2x3, 200 GPM, 150 TDH, bronze
trim.

2-Gould Triplex Pumps, 6x6.
3-Water Meters, Neptune 1½ style 3.

Permitut Water Softening System.

2-Jennings Vacuum Pumps, size SD20.
24"x24" Coal Crusher, single roll.

ABOVE UNITS CAN BE PURCHASED COMPLETE, OR INDIVIDUALLY

Pelton Water Wheel, bronze casing, wheel
& buckets.

Nash #7 Hytor.

5-Dracco Dust Collectors, Type AAA.

Spray Cooler, 5'x30".

Cast Iron Column, 24"x16".

2-Steel Tanks, lead lined, 6'x17"x1½".

2-100 cu. ft., two lift, Gas Holders.

Large lot Boiler Breaching Catwalks.

OTHER EQUIPMENT IN STOCK AT OUR WAREHOUSE**CENTRIFUGES**

40" perforated, steel.

40" perforated, SS.

24" Bird, CH. SS.

COLUMNS

8'x36"x1½" Absorption (2—UNUSED).
6'x24"x14" Scrubber, 5' heads, 225 PSI.
6'x49"x1½" Bubble Cap, 19 trays.
6'x29" Bubble Cap, SS, 21 trays.

DRYERS

1106-35 Roto Louvre.
Tunnel Truck 9'x35"x9", cap. 14 trucks.
Turbulaire N2 Spray, with filter.
Stokes, Rotary, Vacuum, 30"x8", Complete.
Bufflovak 5'x6" Atmos. single drum.
Stokes, 4'x9", Atmos. double drum.

FILTERS

8'x12" Feinc, all steel.
8'x10" Oliver, wood & steel (3).
11'6"x18" Oliver, all steel.
4'x5" Oliver, SS & Wood (2).
#7 Sweetland, 2" spacing, 28 leaves.
36", 35 chambers, center feed, open.

KILNS—COOLERS—DRYERS

7'x60"x1½" with lifters.
6'x14'x9'16" Struthers-Wells (NEW).
5'x67"5/16" with lifters.
4'x16"x1½" lava with burner & stock.
25'x15"x1½".
9'6"x85"2½".
10'x90"x9'16" Allis Chalmers.
8'6"x110"x1½".
9'6"x8'6"x200"x2½".
24"x24" Simco Cooler.

ABOVE IS ONLY PARTIAL LISTING OF OUR INVENTORY

Heat and Power Co., inc.

70 PINE STREET

HAnover 2-4890

NEW YORK S. N. Y.

MACHINERY & EQUIPMENT MERCHANTS

This Equipment Can Be On Its Way—Tomorrow

Stock No.	Description
3103	Sperry 30" cast iron Plate & Frame Press with 34 chambers; closed delivery.
3294	Shriver 30" Cast Iron, Rubber Covered P. & F. Elite Press, 34 chambers; closed delivery.
3484	Shriver 30" Cast Iron Reheated, 37 Chamber Press; open del.
3215	Shriver 18" Cast Iron Reheated, 28 Chamber Press; open del.
3327	Special Lot of Filter Press Skeletons: 16", 24", 30", 36".
2729	Ollier Dorco Rotary Vacuum Filter: 6' x 3'; Nickel contacts.
3317	Bird's Large Rotary Vacuum Filters: 2' x 4' and 4' x 6'.
2335	Gesselland No. 7 Plastic Lined Filter, also Sweetland No. 2.
3294	Industrial Tank Type Vertical Filter; 17 screens; 192 sq. ft.
5497/53	Tolhurst 40" Centrifugal Extractor with Everdur perforated basket; with two speed 20/5 HP motor.
3497/B1	Tolhurst 26" Tolhurst Centrifugal Extractor; motorized.
2945/W4	Tolhurst 40" overdriven, self-balancing Centrifugal Extractor; copper perf. basket; 7½ HP motor.
3240/M13	Sharples Super Centrifuge M84.21-11Y Stainless Steel 1500 RPM with 3 HP.
3315/E1	Premier Type U3 Colloid Mill, 10" S. S. rotor; 30 HP.
3272/L1	Premier L15 15" rotor Colloid Mill with 35 HP motor.
3387/P10	Eigenbach QV 10" Colloid Mill with 5 HP motor.
1609/F2	U.S. Stainless Steel Colloid Mill; 3½" rotor with two motors 3 HP.
3691	Bach-Ross Vacuum Pumps, wet and dry; large selection.
2746	Buffalo or Devine Dry Vacuum Pump: 10" x 10".
9326	Kinney HI Vacuum Pump Model DVD, 10" x 14"; 700 CFM.

FIRST MACHINERY CORP.
157 Hudson Street,
New York 13, N. Y.

For Sale

1-Eigenbach Stainless Steel Home Mixer, complete with a 7½" MP Explosion-Proof Motor.
1-Baker-Perkins 100 Gal. Stainless Steel Mixer, double-arm, sigma blades, with 20 hp explosion-proof motor.
1-De-Dietrich 75 Gal. Brighton Mixer.
5-Pebble Mills 40 to 500 Gal.
10-Pony Mixers, 8, 18 and 40 Gal.
1-Motor Driven Belt Conveyor.
3-6" Premier Colloid Mills, watercooled.
2-Z-281 Mikro-Pulverizers with 10 hp Motors.

SPECIALIZING IN REBUILT MACHINERY**Irving Barcan Company**

249 ORIENT AVE.
JERSEY CITY 5, N. J.
Phone—DFlaware 2-6895-6

BOILERS

10 to 5000 H.P.

Diesel, Steam Turbine, Engine

GENERATORS

Heavy Power Equipment
Industrial — Chemical Process
Equipment

NEW—RECONDITIONED—USED

DEAN G. STRICKLER & ASSOCIATES

1346 Connecticut Avenue, N. W.

Washington 6, D. C. • DuPont 2388



"BRILL FILLS THE BILL" . . . OUR QUARTER CENTURY OF
DISTINGUISHED SERVICE TO INDUSTRY IS YOUR ASSURANCE
OF TOP VALUES, UTMOST QUALITY AND DEPENDABILITY!

DRYERS—KILNS

- 1—9'0" x 6'6" x 200^{1/2}" shell, 4-16" tires complete.
- 1—8' x 135^{1/2}" shell, 2-14" tires, complete.
- 1—8' x 115^{1/2}" shell, 2-14" tires, complete.
- 1—8'6" x 108^{1/2}" shell, 2-14" tires, complete.
- 1—10' x 90^{1/2}" shell, 2-14" tires, complete.
- 1—9'6" x 83^{1/2}" shell, 2-14" tires, complete.
- 1—8' x 60^{1/2}" shell, 2-8" tires, complete.
- 1—Link Belt 11'8" x 35' Roto-Louvre with hoods, blower, etc.
- 1—Link Belt 27' x 8' monel Roto-Louvre, coils, ion, etc.
- 6—Rotary Dryers 7' x 70', 7' x 60', 5' x 67', 4'6" x 40', 4'8" x 35', 4' x 25'.
- 4—Louisville Rotary Steamer Tube Dryers 6' x 30', 6' x 30', 4'6" x 35'.
- 3—Bullock 20', 15, 7 and 3 Shelf Vacuum Dryers 42" x 42".
- 5—Stokes & Bullock Rotary Vacuum Dryers 30" x 6', 3' x 15', 6'6" x 38'.
- 1—Blow-Knox Stainless Steel Rotary Vac. Dryer 42" x 6'.
- 1—Bullock 32" x 100' Atmos. Double Drum.
- 1—Single Drum 60" x 80' Flaker.
- 1—14 Truck steam heated Dryer 1680 sq. ft.
- 2—Devine 17 shell double door Vacuums Dryers 59" x 78".

FILTERS

- 6—Valox Pressure Filters 360 and 540 sq. ft.
- 2—Sweetland #12 with 36 and 72 leaves.
- 1—Sweetland #7 with 27 steel leaves.
- 8—Oliver Rotary Vacuum 11'6" x 14', 8' x 12', 8' x 10', 8' x 8', 3' x 4', 3' x 2'.
- 3—Elmon Rotary Vac. 8' x 8', 4' x 8', 4' x 4'.
- 1—Oliver Rotary Vacuum Pressure Filter 3' x 4' steel.
- 1—Oliver 8' x 8' Rotary Precoat Filter, rubber-lined.
- 1—Feinc Rotary Vacuum 8' x 12' steel with drive, etc.
- 2—Kirby 42" P&F, cast iron, 55 chambers, 2".
- 4—Shriver 36" P&F, 30 chambers, c.l., open delivery.
- 1—Sperry 36" Recessed, 48 chambers, C.I., open delivery.
- 5—Shriver 30" 36 chambers, C.I., open delivery.
- 9—Sperry 24" P&F, 16 chambers, C.I., closed delivery.
- 1—Shriver 24" Recessed, 30 chambers, C.I., open delivery.
- 3—Shriver 18" Recessed, 30 chambers, C.I., open delivery.
- 2—Sperry Aluminum 20" and 24" P&F, 22 and 26 chambers.
- 1—Shriver Aluminum 12" P&F, 8 chambers.

CENTRIFUGALS

- 1—Bird 48" suspended, bottom discharge, steel perforated.
- 1—Tolhurst 48" Center Slung S.S. perforated basket.
- 1—AT&M 42" Suspended S.S. bottom discharge, perforated.
- 6—AT&M 40" Bronze Basket, bottom discharge, perforated.
- 1—Fletcher 40" Suspended, Bottom Discharge, S.S., perforated basket.
- 2—Sharples C27, C30, S16 S.S. Super-D-Hydrators.
- 1—Tolhurst 32" Suspended Monel, bottom discharge, perforated.
- 2—Bird 30" x 50" solid bowl, stainless.
- 1—Sharples P14 S.S. Super-D-Center.
- 4—Sharples #16 S.S. and steel.

PULVERIZERS

- 3—Raymond 5 roll, 4 roll High Side Mills complete.
- 1—Bauer 36" Attrition Mill 2—50 HP motor.
- 17—Patterson, Abbo Pebble & Ball Mills 60 to 1000 gals.
- 2—Premier Colloid Mills 8" dia., S.S.
- 1—Eppenbach QV7 Colloid Mill.

- 2—Jeffrey 36" x 24", 26" x 12" Hammer Mills.
- 2—Raymond 12', 4' Air Separators.
- 1—2 Roll Rubber Mill 8" x 12".
- 2—Mikro No. 151 Pulverizers, 5 HP motors.
- 1—No. 6 Mikro Atomizer, S.S., 20 HP motor complete.
- 1—Fitzpatrick Commuting Mill 5 HP.

SCREENS

- 1—Selectro S.S. double deck 4' x 18'.
- 5—Sprout Waldron S.S. single deck, 40" x 84".
- 1—Robinson, Rotex Single Deck 40" x 94", 40" x 104".
- 1—Tyler Hammer 4' x 7' Single Deck.
- 3—Tyler Hammer 3' x 5' Triple Deck.
- 1—Abbe #2 Blitzeness Sifter.

MIXERS—ALL TYPES

- 7—Baker Perkins 200, 100, 20 and 9 gals., jacketed, double arm, sigma blades.
- 1—Baker Perkins 300 gal. Unidur S.S.
- 1—Baker Perkins 2 gal. Stainless.
- 1—Duy 100 gal. Cincinnati jktd. double arm.
- 1—Duy 30 gal. Imperial jktd. double arm.
- 10—Duy 200^{1/2} to 3000^{1/2} Powder Mixers.
- 12—Electric Portable Agitators 1/4 HP to 5 HP. NEW.
- 4—Duy, Ross, 8 and 50 gal. Pony Mixers.

MISCELLANEOUS

- 30—Bucket Elevators, steel housings, 34' to 90' centers, 8" x 5" to 24" x 8" buckets.
- 7—Stokes Vacuum Pump 15 to 100 CPM.
- 1—Milnor Roy Proportioner Pump, S.S. and Hustlebury, 10 GPM.
- 5—Devine, Bullock Condensers and Receivers, 30 to 90 sq. ft.
- 7—Groen 150, 125 gal. Stainless Steel, jacketed, agitated, kettles.
- 4—Stokes DDS, D4 Rotary Tablet Machines.
- 5—38" dia. Stainless Steel Revolving Pans.
- 1—Nash Hytor Vacuum Pump 440 CPM.
- 10—Olivite Duriron & rubber Centrifugal Pumps, 1½" to 4".

SPECIALS

- 1—8'6" x 200', 3/4" shell, Rotary Kiln, 2-14" tires complete.
- 1—8' x 135', 3/4" shell, Rotary Kiln, 2-14" tires complete.
- 2—Oliver monel 8' x 10' Rotary Vac. Filters.
- 1—Rogers Spray Dryers 16' dia. with all accessories.
- 4—Pneudrier 100 gal. glass-lined Stills with condensers, recirc. water.
- 4—Steel 2000 gal. jacketed, agitated, 200 psi Reactors.
- 1—Pneudrier 350 gal. glass-lined, jktd. agitated Reactor.
- 3—Depp 250, 150 gal. jacketed, agitated kettles.
- 5—Steel Storage Pressure and Acid Vessels 3500 to 20,000 gals.
- 1—Quadruple Effect Evaporator, brass tubes 16,000 sq. ft.
- 1—Bullock VRC, stainless steel Single Effect Evaporator 94 sq. ft.
- 1—Bullock VRC, Triple Effect Evaporator, 900 sq. ft.
- 1—Bullock 6' dia. Vacuum Crystallizer.
- 2—NEW Absorption Towers, 13,500 gal. cap.
- 12—Steel Tanks 9000 to 160,000 gals.
- 12—Tubular Condensers 200 to 1000 sq. ft.

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3500 gal. working cap. Steam-Jacketed, Double-Arm Mixing Tanks for mixing, storing or processing of your materials.

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MONORAIL CRANE: 3 tons capacity, 90 ft. runway, 1yd Mayward motor driven clam shell, 220 volts, D.C.

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Stainless Steel Tanks, new, 100 and 200 gal.

2—300 gal. 2311 Stainless Tanks—new.

1—Stainless Tank No. 436 Chrome, vert. 2" dia. 10' deep.

20—Steam Jacketed Kettles, Stainless Steel, Copper & Aluminum, 5 to 250 gals.

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60—Pump—Piston, 1½" x 10" & 24" x 10".

50—Pumps—steam and electric.

1—New Glass Nach Centrifugal Pump, 100 rpm.

1—Jewett, 12" dia. 12" high.

1—Bullock Jacketed Impregnating Tank 42 x 52'.

1—4 x 2 Sturtevant Jaw Crusher.

SPECIAL: 6—3000 gal. Steam Jacketed Kettles with Turbo Agitators.

1—3x1 Patterson Ball Mill, Manganese Lined, with motor.

1—Abbe Pebble & Tube Mill 5" x 22", lined.

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1—42" x 16" Allis-Chalmers crushing rolls.

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2—24" x 16" Ringers crushing rolls.

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15 Tons of 1½" x 2" Manganese Steel kalls.

8½" x 60", 7½" x 60", 7" x 60", 6" x 60", 5" x 25",

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New dryer and kilns.

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- 1 Aluminum Perforated Plate Column, 28" dia. x 38 plate.
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- 1 Copper Perforated Plate Column 24" dia. x 14 plate.
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- 1 Steel Bubble Cap Column, 8 plates 18" dia. and 19 plates 8" dia.
- 1 Stainless Steel T316 Rasching Ring packed column, 24" dia. x 8" high.
- 1 Stainless Steel T316 direct fired Vacuum Still, 225 gal.
- 2 Copper Vacuum Stills, 48" dia., jacketed and agitated.

CONDENSERS—EXCHANGERS

- 3 Aluminum tub, 160 sq. ft.
- 7 Copper tub, 65, 75, 85, 330, 340, 420, 487 sq. ft.
- 1 Stainless Steel tub, 39 sq. ft.
- 1 Stainless Steel Bundle, 180 sq. ft.

- 4 Stainless Steel Coil Condensers, 40 sq. ft.

DRYERS—EVAPORATORS

- 1 Louisville Rotary Steam Tube Dryer, 5" dia. x 20' long; with screw press.
- 1 Fox Dryer or crystallizing Kettle, 10" dia. x 2' long.
- 1 Stokes #259A Jacketed Vacuum Rotary Dryer, 18" dia. x 42' long, with pump and condenser.
- 2 Atm. Double Drum Dryers, 22"x38".
- 1 Cummer Rotary Hot Air Dryer, 46" dia. x 26' long.
- 1 Struthers Wells Evaporator, 100 sq. ft. tube bundle.
- 1 Copper Vacuum Evaporating Pan, 6" dia., jacketed.
- 2 Copper Vacuum Pans, 4" dia., jktd. & agit.
- 1 Pfautler 60 gal. Glass Lined jacketed Evaporating Dish.

FILTERS

- 1 #12 Sweetland Filter, 36 leaves, 4" centers.
- 1 #22 Sweetland Filter, 11 leaves, 3½" centers.
- 1 Rotary Vacuum Filter, iron, 6" dia. x 3' wide.

- 1 Swenson Rotary Continuous Vacuum Filter; Precoat type, 8" dia. x 8' face, rubber covered and lead acid proof construction.
- 1 FEINC Rotary Vacuum Filter, string discharge, 4½" dia. x 6' face, aluminum.

- 1 Alsop SD-12-WR-30, T316 Stainless Steel.
- 1 Ertel Bronze Disc Filter, EX-40; 90 sq. ft.
- 4 Pressure Leaf Filters, 70 to 90 sq. ft.

- 2 Industrial P. & F. Mfg. Co. Pressure Leaf Filters, 100 sq. ft. each, 1844, 68 sq. ft. rubber lined tank, bronze leaves.

- 9 Filter Presses, Cus iron.

- 1 Sperry 36", 24" ch., open delay, wash.

- 1 Shriver 30", 35 rec. pl. open delay.

- 1 Shriver 24", 40 ch., open delay, wash.

- 1 Shriver 24", 24 ch., close delay.

- 1 Sperry 18", 8 ch., open delay.

- 1 Johnson 18", 8 ch., closed delay.

- 2 Sperry 18", 1 ch., closed delay.

- 2 Louisville 8-roll Continuous Grains Presses, 34" and 36" wide.

KETTLES—REACTORS

- 1 Paterson 10 gal. Inconel Pilot Plant Reaction Kettle, Jktd. & Agit. with Dowtherm unit.
- 1 Stainless Steel, Type 347 Autoclave or pressure tank; 250# pr. Eloc. heated 85° F; 17½" dia. x 9' high.
- 70 Stainless Steel Jacketed Reactors, Clad open Steam jacketed bottom—10, 40, 60, 80, 100, 250, 500 gal. sizes.
- 1 Stainless Steel Kettle, 950 gal. 20# jkt. pr., vertical agitator, Type 347 shell, bolted C.I. top.
- 2 250 gal. Stainless Steel Steam Jacketed Kettles, open top, with double motion agitators.
- 1 150 gal. Stainless Steel Steam Jacketed Kettles, open top, with double motion agitators.
- 1 200 gal. Read Stainless Steel Jacketed Kettle, open top, double motion agitator, 10 HP motor.
- 3000 gal. Horiz. Steel Cooker, Vacuum, Agitated.
- 1 2200 gal. Vertical Steel Cooker, agitated.
- 2 Vertical Steel Cookers, 80# int. pr., 1280 gal., 1660 gal.
- 2 1500 gal. Vertical Jacketed Steel Kettles, 100# int. pr., 90# jkt. pr.
- 3 1500 gal. Vertical Jacketed Agitated Steel Kettles, cladded for pressure or vacuum. 1 Lead Lined Kettle, 150 gal. closed top, with coils, jacket & agitator.
- 1 Aluminum 100 gal. Reaction Kettle, Jktd. & Agit.
- 1 300 gal. Aluminum Jacketed Kettle, open top.
- 1 Glass Lined Kettle, Jktd. & Agit., 50 gal. 6000 gal. Copper Brewing Kettle, agitated.
- 2 Copper Jacketed Agitated Vacuum Kettles, 4" dia. x 4" deep, double motion agitator.

MILLS—PULVERIZERS

- 2 Paul Abbe #26 Pebble Mills, porcelain lined, 32" x 36".
- 1 Hardinge Conical Ball Mill, Steel Liner, 4½" dia. x 24" long.
- 3 Sprout Waldron Attrition Mills, double disc—sizes 16 and 30.
- 1 Williams Hammer Mill, type AK; size A, stainless steel.
- 2 Williams Size 1 Hammer Mills.
- 2 Schutte O'Neill Style D Pulverizers, 18" and 22" dia.
- 1 Mikro Pulverizer, #2-SL.
- 1 Fitzpatrick Model "D" Commuting Machine, Stainless Steel.
- 1 Premier Colloid Mill, type U-3, 6" st. st. rotor.

MIXERS—AGITATORS

- 1 Porter heavy duty jacketed double worm mixer—75 gal.
- 1 Dellenberger 100 gal. Heavy Duty Double Arm Mixer, fish-tail blades, jacketed.
- 2 Stokes Granulating Mixers, 100#.
- 1 Ringer Co. Horiz. Ribbon Type Mixer, jacketed, 600#.
- 8 Horiz. Ribbon Type Powder Mixers, 50#; 100#, 200#, 400# & 2000#.
- 1 Broughton Powder Mixer, double arm, 50 cu. ft.
- 10 Copper Conical Blenders, ½, 1, 7 & 11 cu. ft.
- 1 Turbo Mixer, #23, with 7½" HP motor.
- 2 Turbo 24D Agitator Drives.
- 7 Vertical Gear Motor Agitator Drives, 1 HP 3/60-220-440/68 RPM.
- 2 Lightning Vertical Agitators, 33-B-300, 3 HP 1150 RPM, Expl. Pr. Flange mounted; packing glands.
- 1 Patterson Disk Entering, stainless steel, 100# HP motor.

TANKS

- 3 Aluminum Tanks, closed, 300 gal. & 1350 gal.
- 1 Aluminum Tank, 45,400 gal., New, 12" dia. x 50' long. Can be furnished as 2-12" dia. x 25' long tanks.
- 2 100 gal. Glass Lined Vacuum Tanks.

- 22 Horiz. Welded Steel Tanks, Lastiglass Lined, 15,200 gal.

- 3 Horiz. Welded Steel Tanks, Lastiglass Lined, 3800 gal.

- 4 Vertical open top Welded Steel Tanks, Lastiglass Lined, 3500 and 6650 gal.

- 10 Horizontal Bolted Steel Tanks, Brewery glass lining, 7750 gal. & 8250 gal.

- 18 Vertical Welded Steel Tanks, closed Membrane Lined, 7700 gal., 8000 gal. & 2300 gal.

- 2 Steel Yeast Tanks, 800 gal. with coils and agitators.

- 1 Steel Yeast Tank, 2050 gal., copper coils.

- 3 Vertical Jacketed Pressure Tanks—steel—30# steam jacket—6mm vacuum insulation.

- 3—23" ID x 15' H (approx. 700 gal.)

- 1—23" ID x 10' H (approx. 230 gal.)

- 1—23" ID x 9' H (approx. 195 gal.)

- 15 Vertical Wood Tanks—3800, 4500, 6000 and 8000 gal.

- 1 Vertical Rubber Lined Steel Tank, 8,000 gal.

- 1 Vertical Lead Lined Steel Tank with coils, 200 gal.

**STAINLESS STEEL TANKS
IN STOCK**

- 2 16,200 gal. Vert., closed, T304—NEW
- 1 5700 gal. Horiz. T304—NEW
- 1 3700 gal. Horiz. T302—NEW
- 1 1500 gal. Vert., closed, T304—NEW
- 1 2350 gal. Vert., open, T302—NEW
- 1 1400 gal. Vert., open, 10' L x 57" W x 57" D
- 2 1000 gal. Vert., T304—NEW
- 2 300 gal. Vert., T304—NEW
- 40 Stainless Steel Tanks—from 6 gal. to 450 gal. sizes
- 6 2000 gal. Horizontal Stainless Steel Tanks, 5½" dia. x 18½" long, insulated and agitated. Excellent for transporting, storage or holding.

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- 3 Welded Steel Bins—1884 & 4900 cu. ft.
- 1 Ingersoll Rand Type FB-538 Motor-Blowers 4000 CFM at 2 lb. pr.
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- 1 Bird Suspended 48" Steel Centrifugal, Perforated basket, bottom discharge.
- 1 Sharples #16 Super Centrifuge, stainless steel.
- 1 Hercules Turbine Co. Gas Booster or Compressor, stainless steel, 30 HP motor, 600 CFM at 80 oz. pr.
- 1 Deionizing System, 500 GPM, Zeolite.
- 6 Stainless Steel Hoppers, 6 cu. ft.
- 2 Explosion Proof Motors, 3/60/220-440/1750, ¾ HP to 3HP, NEW.

- 2 Kux Machine Co. Model 25 Rotary Pellet Presses, 21 and 25 punch—with motor and vari-drive.

- 8 Stokes Rotary Pellet Presses, 18 punch, B-2, D-3, D-4.

- 1 Byron Jackson Deep Well Pump, 150 GPM 325' head, NEW.

- 1 Ingersoll Rand Bronze Centrifugal Pump #5ALV, 40 HP motor, 850 GPM at 145' NEW.

- 2 Ingersoll Rand Bronze Centrifugal Pumps, 2½", B-VH, 20 HP motor, 200 GPM at 230'.

- 12 Aurora Bronze Turbine Pumps, II 5, G-6, H-6, NEW.

- 3 Selectro Vibrating Screens, stainless steel, 2' x 7', double deck enclosed.

- 1 Stainless Steel Horizontal Sterilizer or Retort, 10# pr., 24" W x 26" H x 36" L.

- 1 Stokes Vertical Steel Jacketed Vacuum Chamber and Impregnating tank, 30" L x 24" W x 24" D.

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- Sweetland & Oliver Rotary Vac. Filters.

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- Schoell 100 gal. 225 PSI Pressure Tank, 1200 gals.
- Devco 1000 gal. closed jack airtight steel kettle.
- Jacketed Kettles 50-2500 gals.
- 250 gal. Lead Lined Kettle.
- 1000 gal. Lead Lined Tank.
- New Stainless Steel Tanks 500 to 5000 gals.
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- Wetzel 2000 H.P. Atkinson Pulverizer.
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3087	Bogoyak Vacuum Chamber Dryer with 20 shelves: 40" x 42" with Vac. Pump Condenser and Receiver.
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3299	Horizontal Dryers, 6' x 14'7" with tracks, 21" x 3" steam pipe; double door, captain closing heads.
3400	Climax Dryer—Sheridan—Disinfecter: jacketed: 48" x 42" x 8' long; sealed door each end.
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3364	Boiler Rotary Atmospheric Stainless Dryer with hexagonal shell: 30" x 30" long; S/S feed and Aerials.
3168	Louisville Counter Current Mant Lined Rotary Atmospheric Dryer, 30" x 16" long.
3414	Rotary Drum Dryer with nickel drum for steam, 40" x 46".
3383	Type 316 Stainless Roll or Drum steam cored, 32" x 82".
3026	Buffalo Rotary Vacuum Dryer with chrome plated drum, 5' x 12' with accessories.
1190	Buffalo Vacuum Drum Dryer, 5' x 12' Bronze Drum.
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- 22—10,000 & 15,000 Gal. 1/2 inch Horiz.
- 9—3500, 5000 & 10,000 Bbl. Vert.

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1/2 TON WOLF HORIZONTAL MIXER

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- Rotox 52 Screens. 2 deck 5" x 10'.
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- Vacuum Pumps: Stokes 105 CPM. 3 hp.
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- Mill: Hardings 3' x 36" buhrstone lined.

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- 2—33 gallon Series "M" jacketed and agitated with explosion proof 1/3 HP motor, one less agitator

PFAUDLER GLASS LINED TANKS AND RECEIVERS

- 1—200 gallon Model NF, open top, with side entering agitator
- 3—100 gallon Model XF clamp cover open top
- 1—75 gallon jacketed, open top, with side entering agitator
- 1—Model DF, 100 gallon
- 2—60 gallon Model DF open top, with portable agitators
- 4—50 gallon VR, one agitated
- 1—50 gallon, Model VF, closed
- 1—50 gallon, Model XF, closed top, 2 agitated, 3 open, 5 closed
- 1—25 gallon closed top clamp cover with explosion proof agitator
- 2—15 gallon closed top with clamp cover
- 1—15 gallon jacketed, open top, Model JPE-17
- 3—10 gallon type PK-16

DRYERS, VACUUM SHELF

- 1—J. P. Devine #23-5 shelf 40" x 42"—
3 1/16" clearance, complete
- 3—J. P. Devine #23 double door 13 shelf,
38" x 78" x 2-15/16" clearance complete

CONDENSERS AND EXCHANGERS

- 1—Pfaudler 14 sq. ft. glass lined with new extra flimble
- 1—Pfaudler 24" diameter, 7 plate, glass lined
- 1—Stainless steel condenser, having 38-
1/2" tubes 8' long
- 2—Devine 190 sq. ft. admiralty metal condensers and receivers
- 3—Devine condensers and receivers 37 to
100 sq. ft.
- 1—New York Engineering 120 sq. ft. condenser and receiver with brass tubes

* Surplus Equipment, Still Installed. Not Needed By Present Owners. Can Be Inspected Under Power

TANKS, MISCELLANEOUS

- 1—New General Ceramic 130 gallon tank
- 2—300 gallon General Ceramic tank
- 1—General Ceramic 25 gallon acid egg
- 1—50 gallon Metal Glass open top tank

GRINDERS

- 3—Abbe Engineering #25 porcelain jar mill, motor drive
- 1—Abbe Engineering #23 porcelain jar mill
- 1—Abbe type T, V belt drive jar mill
- 1—Shultz O'Neill 16" Limited mill, V belt drive
- 2—Enterprise type 5E, 6" motor driven meat grinders
- 1—J. H. Day 16" ointment mill

At Williamsport Plant

- 1—Zaremba double effect evaporator, 2400 sq. ft. area, copper tubes, complete, 100% installed
- 2—200 gallon open top cooking kettles, 8'6" dia. x 6'6" with coils
- 1—Zenith continuous pulp press with GE 20 HP motor
- 12—Philadelphia vertical type VT agitators
- 1—Gardner 1000 kw generator
- 1—Robinson 20"-48" sifter, 3 separations
- 1—Fonatool Corp. HCL absorption system
- 3—10,000 gallon rubber lined horizontal tanks

At Philadelphia Plant

- 1—Pfaudler 400 gal. Jkkd and agitated vacuum reactor
- 2—7500# dry powder mixers 6'x7'x9' long and discharge
- 2—Rosenfeld 21" imp. mills, complete with feeding conveyors and air separators
- 1—2500 gallon ASME jacketed and agitated steel reactor
- 1—1000 gallon lead lined agitated sulphuric acid reactor
- 2—500 gallon lead lined agitated sulphuric acid reactors
- 8—Hollingshead horizontal jacketed agitated steel crystallizers
- 1—10,000 gallon horizontal steel storage tank
- 2—1000 gallon agitated mixing tanks 4'-18", 24", and 30" filter presses, iron wood
- 2—Pfaudler 60" jacketed evaporating dishes, glass lined
- 1—Leifey heavy duty hammermill
- 1—Abbe 2 1/2" rotary crusher
- 2—Syntron vibrators
- 1—Shriver 24" aluminum filter press, 14 chambers, 2 eye, closed
- 1—Shriver 24" aluminum filter press
- 3—American Hard Rubber acid proof pump, 1 HP, motor drive
- 4—Coombs gyratory sifters, 20" and 24"
- 4—Claridge, Sturtevant, Buffalo Forge blowers 27"-36" blades
- 1—Shriver 18"-x16" bronze 4 eye filter press, 18 chambers closed delivery
- 7—Coald. Worthington, Dresser, Union, Viking pumps, from 1 1/2" to 4"

MISCELLANEOUS

- 1—1000 gallon steel still, with 18" copper column, 12' high, 21 pintles bubble cap, spaced 6" apart, with all copper condenser
- 1—Burkard 50 gallon copper steam jacketed Naphtha still, complete
- 1—Pfaudler 13 gallon open top jacketed kettle
- 1—75 gallon open top agitated kettle, steel
- 1—Dopp 150 gallon east iron jacketed open top kettle
- 1—Briancon 1 HP refrigeration unit
- 2—J. P. Devine 15 gallon percolators
- 1—Sharples Super centrifuge, Model MAFME motor driven
- 1—HPM 15 ton fruit press, with stainless steel trays, 23" x 25"
- 1—15 gallon closed top vacuum receiver,
- 1—New 300 gallon galvanized closed tank, horizontal

VACUUM PUMPS

- 2—Devine 6" x 8" 10 HP, 198 CPM
- 3—Devins 4" x 6", 5 HP, 36 CPM
- 2—Beach Russ 100W, 5 HP
- 1—Bump 1 1/2" stainless steel 1/4 HP
- 2—Blockmer 2" iron centrifugal MD
- 1—New Proportioners 7 to .7 GPM sulphuric acid
- 1—Fairbanks Morse

FILTERS

- 1—Republic 18" x 18" stainless steel plate filter
- 2—New General Ceramic 13 gal suction filters Figure 67
- 1—Alois 13 1/2" aluminum disc filter
- 1—Cuno auto-clean filter
- 1—Shriver 18", 14 chamber bronze P & F filter press closed del

ROTAMETERS-FISCHER & PORTER

- 1—Figure 255, 1/2", rated 24 to 240 gallons per hour, iron construction
- 1—Figure 255, 1", 60 to 600 gallons per hour, iron construction

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SEARCHLIGHT SECTION

NOBODY HAS A BETTER SELECTION than
REACTORS — STILLS — VACUUM TANKS — RETORTS

Stock No.	Description
3436	Stainless Steel Reactor: 24" x 40", coil heated; agitated.
3417	8/8 Jacketed Reactor: 24" x 40"; with agitator.
3168	8/8 500 Gal. Jacketed Reactor: 6" x 30" straight side.
3220	8/8 200 Gal. Closed Top Tanks: 30" x 60"; agitated.
3242K2	Welded Jacketed and Agitated Reactor, 250 Gal. with 8/8 Condenser and Reboiler.
3424K2	8/8 475 Gal. 8" x 8" Tank; agitated and jacketed.
3169D7	8/8 Drop-in Jacketed Reactor: 40" x 8".
3494	Drop Cast Iron 650 Gal. Fully Jacketed Mixing Kettle; closed top with agitator: 60" x 60".
2914	2 Deep Cast Iron Jacketed Kettles, 250 gal.—60" x 30".
3039	NEW! Buffalo 900 Gal. Steel Jacketed, Agitated Mixing Kettle: 4" x 8'2".
3273	Pneudier Glass Lined Jacketed and Agitated: 47" x 62".
2834	Steel Vacuum Receiver: 400 Gal.; 9" x 7".
3470	Stainless Steel Bubble Cap Column: 16 sections; 8½" x 10".
3452	Pneudier 350 Gal. Glass Lined Tanks; Jacketed; Agitated; size 34" x 8'2".
3692	Stainless Steel Heat Exchanger: 20" x 18"; 200 sq. ft.
1060/C5	C. H. Wheeler Boroflow Condenser; copper tubes 4,000 sq. ft.; Cast Iron shell 54" x 17'2".
2896	Davies Single Effect Evaporator; Calandria type: 20" x 8".
1060/C1	Long Tube Double Effect Evaporator; Copper Tubes: 2,000 sq. ft.
3473	Zarombi Single Effect Cast Iron Evaporator with copper tubes: 130 sq. ft.; 40" x 10'3" overall.
3274	Hewson Quadruple Effect Long Tube Evaporator; Vertical Film type with 5 Vapor heads.
1060/C3	Jen. Gates Copper Quadruple Effect Calandria type Evaporator: 2,000 sq. ft.

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SPECIAL OFFERINGS

DRYERS

- Buffovak Double Door Vac. 20 Shelves 60" x 80".
- Buffovak Vac. 12 Shelves 42" x 42".
- Stokes #130 Vac. 6 Shelves 42" x 36".
- American 42" x 120" Double Drum.
- Nickel Plated Drum 48" x 46".
- Buffovak 6" dia. Jack. Crystallizer.

FILTERS & FILTER PRESSES

- Sweetland #12 with 36 leaves 4" o.c.
- Shriver 42" C.I. Plate & Frame 26 Sh. 1" Cake.
- Shriver 42" Wood Plate & Frame, Wash. Type—O.D.
- Ind. 30" Wood Plate & Frame, Wash. Type—C.D.
- Wood Plate 18" Wash. Type, C.D.
- Shriver 18" C.I. Center Feed, O.D.

PULVERIZERS

- Mikro 2 TH with 10 HP Motor.
- Mikro 2 TH less Motor.
- Raymond 16" Screen Mill—5 HP.
- Fitzmill—Model "D"—S.S.—3 HP.
- Gruendler W.B. Jr. 10 HP Motor.
- Robinson Size 1212 Rotary Cutter—10 HP. Motor.
- Mikro 2 FF with S.S. & Bronze Parts—10 HP. Motor.

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Model 420 Base Mounted with 100 HP—G.E. Tri/Clad 3/90/220/440 built-in motor. Complete with self-contained cooling system
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ROTARY DRYERS

2...70" x 35' Rugged Coles A. 10'
Single Shell: 4x20, 4x15, 5x20, 5½x7x60.

MISCELLANEOUS EQUIPMENT

Hammertone Jeffrey 26 x 23 B. & G. x 38 Flotation-Wallman Oil Filter
Dimes 60" x 3 Roll Type I.M. Magnetic Separator.
8", 10" & 16" Mechanical Air Separators.
8", 10", 12", 14", 16", 18", 20", 22", 24", 26", 28", 30", 32", 34", 36", 38", 40", 42", 44", 46", 48", 50", 52", 54", 56", 58", 60", 62", 64", 66", 68", 70", 72", 74", 76", 78", 80", 82", 84", 86", 88", 90", 92", 94", 96", 98", 100", 102", 104", 106", 108", 110", 112", 114", 116", 118", 120", 122", 124", 126", 128", 130", 132", 134", 136", 138", 140", 142", 144", 146", 148", 150", 152", 154", 156", 158", 160", 162", 164", 166", 168", 170", 172", 174", 176", 178", 180", 182", 184", 186", 188", 190", 192", 194", 196", 198", 200", 202", 204", 206", 208", 210", 212", 214", 216", 218", 220", 222", 224", 226", 228", 230", 232", 234", 236", 238", 240", 242", 244", 246", 248", 250", 252", 254", 256", 258", 260", 262", 264", 266", 268", 270", 272", 274", 276", 278", 280", 282", 284", 286", 288", 290", 292", 294", 296", 298", 300", 302", 304", 306", 308", 310", 312", 314", 316", 318", 320", 322", 324", 326", 328", 330", 332", 334", 336", 338", 340", 342", 344", 346", 348", 350", 352", 354", 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COMES UP TO YOUR EXPECTATIONS

IN QUALITY - IN VALUE

GELB MACHINERY

- 1—Bird Stainless Steel Filter, 18" x 28".
- 1—Shriver 24" C. I. P & F Filter Press, Closed Delivery, 24 Chambers.
- 1—Sperry Aluminum 42" P & F Filter Press, 34 Chambers, Closed Delivery, 3" Frames (New).
- 1—Pfaudler Glass Lined Jacketed Kettle, 150 Gals., Series M.
- 1—Pfaudler Glass Lined Jacketed Vacuum Reactor, 500 Gals., Series LL.
- 1—Royle #5 Perfected Extruder with 125 HP Motor.

- 1—Koven Stainless Steel Mixing Tank, 1000 gals. with Netco WT-37 Drive, 20 HP Explosion Proof Motor and Turbine Type Agitator.
- 2—Buflovak Vacuum Shelf Dryers, 20 Shelves, Size of Shells 5" x 160".
- 10—Steel Heat Exchangers, 100—1000 Sq. Ft.
- 10—Baker Perkins Steel Jacketed Mixers, Sigma Blades, 250 Gals. Cap.
- 1—Gruendler Pulverizer with 30 HP Motor.
- 10—Steel Vacuum Reactors with Coils, 1300 Gals. Cap., 80 PSI.
- 1—Stainless Steel Type 316 Storage Tank, 1500 Gals. Cap.
- 2—Steel Storage Tanks with coils, 6700 Gals. Cap. Each, 80 PSI.
- 2—Steel Pressure Tanks, 10,000 Gals. Cap. Each, 125 PSI & 250 PSI.
- 25—Steel Storage Tanks, 9,000—17,500 Gals. Cap.
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- 1—Pfaudler Glass Lined Condenser, 12 sq. ft.

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NEW EQUIPMENT

New Packaging & Handling Equipment

- Portable Bin Boxes**—Reduce handling labor and product loss, eliminate bags. Tote System, Inc. 101
- Stacking Box**—Can be used as stacking bin, bin or pallet; easily knocked down. Paltier Corp. 102
- Stainless Conveyor Belt**—Widest polished belt ever made. Metalcraft Div., Grand Forks Mfg. Co. 103
- Bag Holder**—Stacking bag snap-up holder provides positive grip for filling operations. Richardson Scale Co. 104
- Screw Conveyors**—Absence of lap joints and crevices makes for sanitation. Kornylak Engineering Corp. 105
- Power Shovel**—Can be loaded while the tractor is stationary; comes with attachments. Lessmann Mfg. Co. 106
- Barrel Cleaning Machines**—Provides continuous washing, rinsing and phosphating. Morrissey Industries, Inc. 107
- Two-Wheeled Tractor**—Has a long, low-profile material bin confined spaces. Phillips Mine & Mill Supply Co. 108
- Platform Truck**—Telescopic lift to 124 in.; capacity of 4,000 lb. Yale & Towne Mfg. Co. 109
- Hand Trucks**—Extra heavy-duty low-lift platform Work-saver. Capacity, 7,500 lb. Yale & Towne Mfg. Co. 110
- Electric Fork Truck**—SpaceMaster Model J; lightweight and economical. Lewis-Shepard Products, Inc. 111
- Electric Fork Truck Drive**—With variable voltage control terminals. Capacity, 1,500 lb. Lewis-Shepard Co. 112
- Power Scoop**—For unloading bulk materials from box cars. Jeffrey Mfg. Co. 113
- Clamping Forks**—Handles drums and other cylindrical objects with truck forks. Lewis-Shepard Co. 114
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- Packing Filter**—Adapts to laboratory and on-line conveyor filtering. Stokes & Smith Co. 116
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- Cup Expander**—Reduces leakage in hydraulic and pneumatic cylinders, pumps, compressors. HPL Mfg. Co. 123
- Metallic O-Rings**—Withstand high temperatures, oils and solvents. United Rubber Products, Inc. 124
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- Welder's Trash**—Designed to accommodate one gas and one oxygen cylinder. Palmer-Shife Co. 126
- Electric Clutch**—Allows 10 percent increase in speed of paper machinery. Warner Elec. Brake and Clutch Co. 127
- High-Level Cage**—Positioned by telescoping boom, replaces ladders and scaffolding. Donwill Co. 128
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- Laboratory Table**—Versa-Table unit can be installed in eight different ways. Fisher Scientific Co. 132
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Variable-Speed Drive—Mounting dimensions are interchangeable with standard motors. Sterling Elec. Motors, Inc. 141

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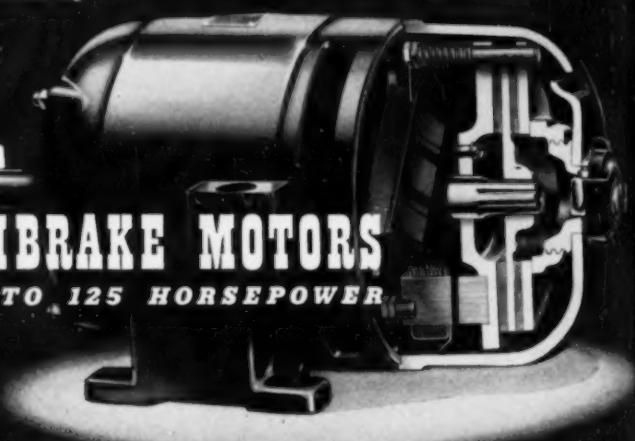
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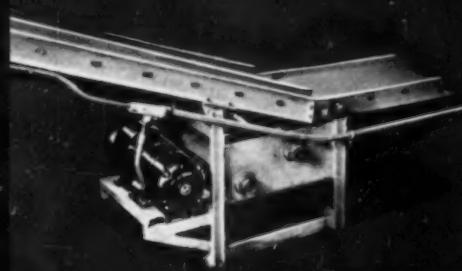
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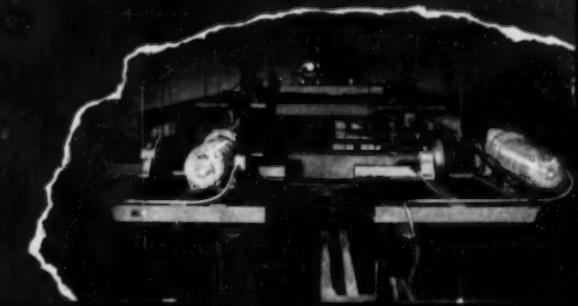
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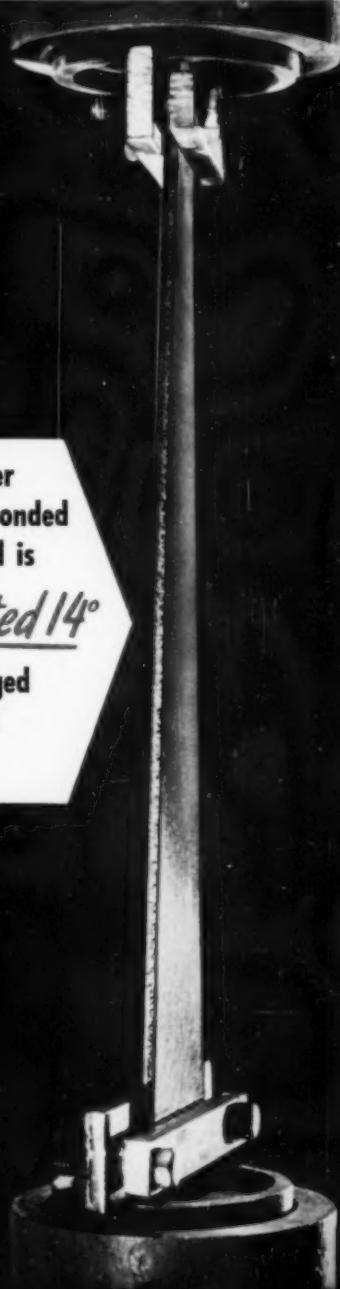


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